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Childhood Maltreatment and Working Memory: Considering the Influence of Anxiety and Emotion Dysregulation

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CHILDHOOD MALTREATMENT AND WORKING MEMORY: CONSIDERING THE INFLUENCE OF ANXIETY AND EMOTION DYSREGULATION

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ABSTRACT

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This study investigated female college students with and without a history of childhood maltreatment and working memory ability on a traditional and an emotional working memory task. Individual difference variables of current anxiety and emotion dysregulation were also assessed. Some research reports a working memory deficit among individuals with a history of childhood maltreatment. However, some research has not found a relationship between maltreatment history and working memory. Both anxiety and emotion dysregulation are known to be associated with childhood maltreatment. Also, anxiety and emotion dysregulation are associated with poor working memory performance. Previous research has not considered the influence of anxiety or emotion dysregulation on the relationship between childhood maltreatment and working memory performance. This research did not find a relationship between childhood maltreatment and working memory performance on a traditional or emotional task. Also, anxiety and emotion dysregulation were not found to interact with the relationship between childhood maltreatment and working memory performance. Exploratory analyses did reveal an interaction of childhood maltreatment and a specific trial type within the traditional working memory task. The exploratory results from this study imply value in considering the cognitive components required to execute working memory tasks in future childhood maltreatment research.

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CHAPTER I

INTRODUCTION

Childhood maltreatment is a serious social issue with possible life-long consequences. Millions of cases of child abuse or neglect are reported to Child Protection Services (CPS) every year (Miller-Perrin & Perrin, 2013). These reports do not include cases that went unreported and are likely to include fewer reports of emotional abuse or types of neglect that are difficult to identify. While physical injury, disability, and initial stress are more obvious and immediate consequences, child maltreatment can also lead to long-term negative impacts on mental health, social, and emotional issues. Long term consequences also include delayed cognitive development, poor school performance and dropout, and poor mental health outcomes for adults (Miller-Perrin & Perrin, 2013). Given the prevalence of childhood maltreatment, a great amount of research has been dedicated to better understanding adult outcomes for these early adverse life experiences. However, maltreatment can be difficult to study due to differing definitions, the heterogeneity of maltreatment groups based on age, maltreatment duration, and type of maltreatment experience, as well as the existence of multifactorial and indeterminate outcomes. This may explain conflicting or unclear reports of the negative implications of maltreatment, such as mixed finding of deficits in various cognitive domains. Previous studies identify working memory as the cognitive domain with the strongest relationship with childhood maltreatment, yet other studies find no working memory impairments associated with childhood maltreatment experience (Masson, Bussières, East-Richard,

Mercier, & Cellard, 2015; McLaughlin, 2016). Although working memory and childhood maltreatment experience have been addressed in many studies, the specific working memory deficits are poorly understood. Given the contribution of working memory to adaptive behavior (Hofmann, Schmeichel, & Baddeley, 2012), a clearer understanding of the nature of the deficits could lead to more effective interventions. Emotional arousal in the context of anxiety (Moran, 2016), negative mood (Lavric, Rippon, & Gray, 2003) and emotional stimuli (Kensinger & Corkin, 2003) has been associated with working memory performance. The influence of emotional arousal on working has not been specifically addressed in childhood maltreatment samples. That said, childhood maltreatment is linked to higher levels of anxiety (Green et al., 2010), as well as emotion dysregulation (Cicchetti, Ganiban, & Barnett, 1991), leading to the question: Does emotional arousal have a greater influence on working memory for individuals with a history of maltreatment than for those without such experiences?

Background of Study

Childhood Maltreatment and Working Memory

Working memory is vital to academic success and is necessary to execute all academic tasks (Best, Miller, & Naglieri, 2011; Jacob & Parkinson, 2015). Currently there are conflicting reports of a working memory deficit for individuals with a history of childhood maltreatment. Some of the literature suggests that individuals with a history of childhood maltreatment display a deficit in working memory (see meta-analysis by Masson et al., 2015); however, many studies show conflicting findings (Bremner et al., 1995; Bremner, Vermetten, Afzal, & Vythilingam, 2004; Stein, Koverola, Hanna, Torchia, & McClarty, 1997). Studies employ a variety of working memory tasks, from

arithmetic problems to letter-number sequencing. Different working memory tasks may result in different working memory abilities tested, leading to conflicting results. Also, childhood maltreatment samples can vary based on age, type of maltreatment experienced, age of maltreatment experience, and gender, which makes the generalizability of results limited. It is currently unclear why a working memory deficit is not consistently reported for childhood maltreatment groups, but in non-maltreatment samples other factors, such as anxiety and emotion regulation, have been found to alter working memory performance. Both anxiety and emotion regulation are known to be linked to childhood maltreatment experience. Thus, the existence of these two individual difference variables along with a maltreatment history may reveal the degree to which working memory suffers in this population.

Childhood Maltreatment, Working Memory, and Anxiety

Anxiety is a commonly reported symptom after childhood maltreatment experience. It can vary from mild levels of anxiety to a clinical disorder such as Posttraumatic Stress Disorder (PTSD). Childhood trauma has been linked to anxiety disorders (Hovens et al., 2010), yet the possible influence of anxiety is not often studied in conjunction with cognitive abilities in this population. In contrast, a large body of research has considered the influence of anxiety on working memory, but not with samples identified as experiencing maltreatment. Anxiety is associated with inferior working memory performance on phonological and spatial working memory tasks (Moran, 2016), and a working memory deficit has been linked to specific PTSD symptomology (Bomyea, Amir, & Lang, 2012). Further, inducing an anxious state, with a

threat of electric shock, has also been linked to poor working memory performance (Lavric et al., 2003). While many studies have found working memory differences that covary with anxiety (Eysenck & Byrne, 1992), other studies have only found differences in working memory performance when the task utilized emotional stimuli (e.g. Caldwell, Krug, Carter, & Minzenberg, 2014; Kensinger & Corkin, 2003; Levens, Armstrong, Orejuela-Dávila, & Alverio, 2017). This literature suggests working memory performance may not just be sensitive to anxiety, but that emotion regulation may also play a role.

Childhood Maltreatment, Working Memory, and Emotion Regulation

Aldao (2013) defines emotion regulation as the processing that allows individuals to alter emotional experiences, expressions, and physiology to adapt appropriately to a changing environment. Individuals exposed to childhood maltreatment are likely to experience emotional arousal but are less likely than non-maltreated peers to receive support and scaffolding to help them learn how to regulate these negative emotions (Camras, Sachs-Alter, & Ribordy, 1996 for a review). This may be why individuals with a history of childhood maltreatment display difficulties with emotional expression and control (Cicchetti et al., 1991; Tran, van Berkel, van Ijzendoorn, & Alink, 2017). Issues with emotion regulation can lead to difficulties in social relationships (Kim & Cicchetti, 2010; Lopes, Salovey, Côté, & Beers, 2005), have been linked to anxiety (Esbjørn, Bender, Reinholdt-Dunne, Munck, & Ollendick, 2012; Hannesdottir & Ollendick, 2007), and may negatively impact adaptation to everyday situations in school, work, and family settings. Researchers have begun to include emotional stimuli (e.g., faces depicting

different emotions) in various cognitive tasks to address how emotion regulation may interact with cognitive abilities (Caldwell et al., 2014; Levens et al., 2017), but studies have not specifically addressed adult samples who have a history of childhood maltreatment.

Therefore, the current study examined the performance effects of emotional stimuli in a working memory task compared to a traditional working memory task in a sample of college students with and without childhood maltreatment experience, while also considering the possible moderating effects of anxiety and emotion dysregulation.

Rationale for the Study

Childhood maltreatment is a widespread problem and many individuals struggle with cognitive and emotional consequences of their adverse early experiences. Even on a college campus, about one third of students will report experiencing moderate to extreme maltreatment as children. Students with a history of maltreatment are less likely to graduate from college and may also experience trauma-related symptoms (Duncan, 2000). As this study included a sample of college students with reported histories of childhood maltreatment, it was specifically equipped to shed light on working memory deficits in this population. Clarifying the possible impact of emotional stimuli on working memory performance may lead to a greater understanding of working memory difficulties elicited in situations involving emotional arousal for students with a maltreatment history. This approach contrasts with previous studies that addressed working memory in isolation; i.e., without considering the impact of emotional arousal on performance.

There is evidence of working memory impairment after childhood maltreatment experience, but little attention has been given to studies with contradictory evidence. Childhood maltreatment is known to relate to many cognitive deficits, but also affects other life domains such as mental health and emotion regulation. Even as anxiety and emotion dysregulation are known to be linked to both childhood maltreatment experience and working memory performance, this author is unaware of any published study that has addressed all these factors together in a single study. The findings from this study will also have practical implications for identifying factors in this vulnerable population of college students which may influence their academic success.

Purpose of the Study

This study aimed to investigate whether female college students with a history of maltreatment were influenced by emotional stimuli in a working memory task differently than individuals without a maltreatment history. Anxiety and emotion dysregulation were also examined as moderators of the observed association between childhood maltreatment and working memory performance. Both anxiety and emotion dysregulation are recognized as impacting working memory and it may be the interaction of maltreatment with one or both of these individual differences results in observable working memory deficits.

Q1 Are individuals with a history of childhood maltreatment influenced by emotional stimuli in a working memory task to a greater extent than individuals without a maltreatment history?

Q2 Among individuals with a history of childhood maltreatment, does anxiety moderate the relationship between childhood maltreatment and working memory performance?

Q3 Among individuals with a history of childhood maltreatment, does emotion dysregulation moderate the relationship between childhood maltreatment and working memory performance?

These questions were addressed in a study that included both experimental and quasi-experimental methods. The first research question compared two groups differing in childhood maltreatment history on working memory performance on two tasks varying in emotional content. To assess childhood maltreatment, participants completed the Childhood Trauma questionnaire. Working memory was assessed with two versions of the N-back. One N-back was given in a traditional form, using neutral stimuli (digits) while the other version included pictures of emotional faces. The performance on the N-back tasks were compared to examine group differences, task differences, and the interaction between group and task.

To address the second research question, anxiety was assessed with two mental health symptom surveys. The anxiety scale from each measure was combined into one score (see Data Analysis for details). Grouping participants by both maltreatment history and anxiety allowed the investigation of whether maltreatment, anxiety and task content interact to impact working memory performance.

To address the third research question, emotion dysregulation was assessed with a survey. The total score from this survey was used to create emotion dysregulation sub-groups among the two larger maltreatment groups. This allowed the examination of the three-way interaction of maltreatment, emotion dysregulation, and task content on working memory performance.

Research Question One

To examine if working memory performance of individuals with a history of childhood maltreatment differs from control participants when the task is manipulated in terms of emotional content a 2 (number, emotional) x 2 (child maltreatment, control) mixed (within and between subjects) repeated measures ANOVA was used to analyze N-back scores and response times.

Hypothesis One. It is hypothesized that the number N-back scores would not differ between the childhood maltreatment group and comparison groups; however, the childhood maltreatment group would exhibit lower scores on the emotional N-back than the comparison group. This would indicate an interaction between the emotional content of the working memory task and the childhood maltreatment history (hence, differences seen in working memory performance between condition but only for the maltreatment group). See Figure 1 for an example.

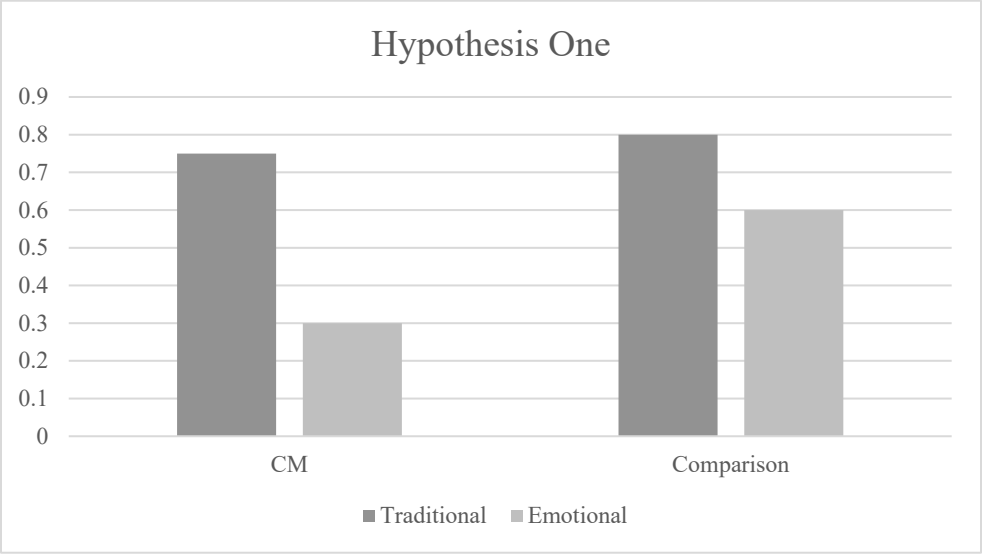


Figure 1. Hypothesis One

Research Question Two

To examine a possible moderation effect of current anxiety symptoms a 2 (number, emotional) x 2 (child maltreatment, control) x 2 (high anxiety, low anxiety) mixed (within and between subjects) repeated measures ANOVA. This analysis was completed on N-back accuracy scores and response times.

Hypothesis Two. It is hypothesized that individuals with a history of childhood maltreatment and high anxiety would exhibit the lowest working memory scores but only for the emotional N-back. See Figure 2 for an example.

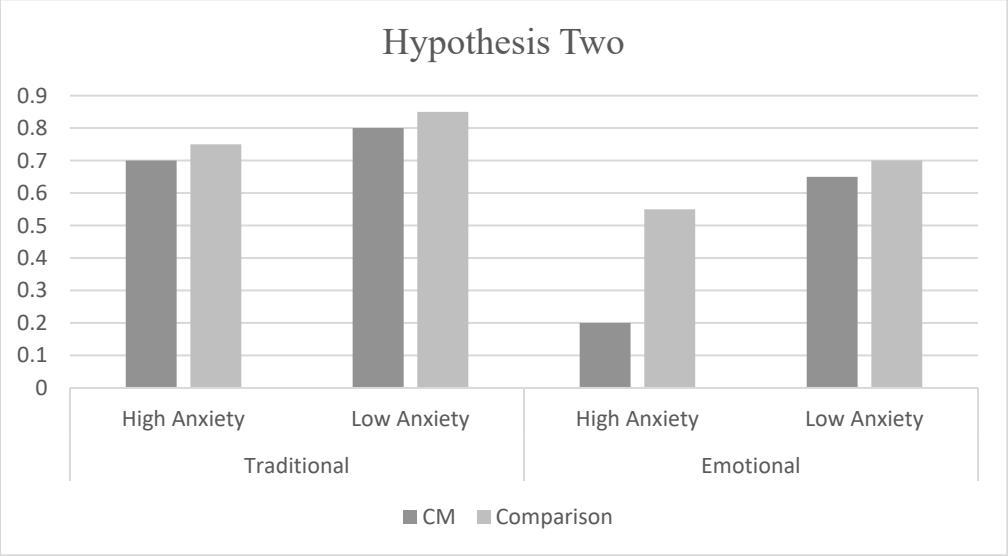


Figure 2. Hypothesis Two

Research Question Three

To examine a possible moderation effect of emotion dysregulation in a 2 (traditional, emotional) x 2 (child maltreatment, control) x 2 (high dysregulation, low

dysregulation) mixed (within and between subjects) repeated measures ANOVA. This test was completed on N-back accuracy scores and response times.

Hypothesis Three. It is hypothesized that individuals who demonstrate a history of childhood maltreatment and high emotional dysregulation would exhibit lower working memory scores but only in the emotional N-back. See Figure 3 for an example.

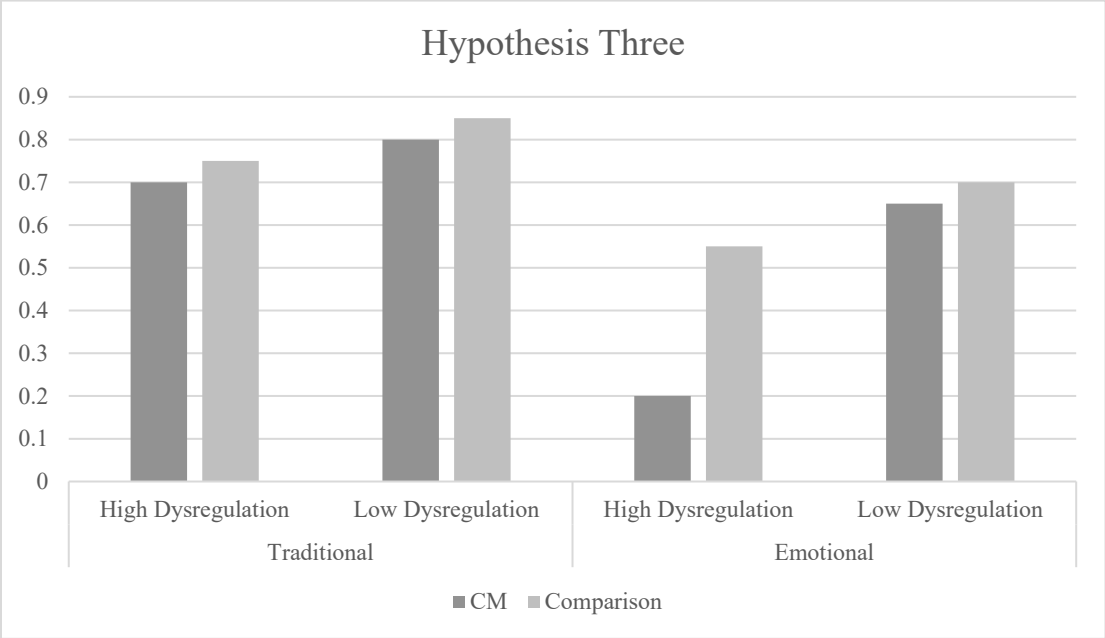


Figure 3. Hypothesis Three

Summary

The goal of this study was to investigate the relationship between childhood maltreatment experience and working memory in a traditional and emotional task in female college students. The possible influence of current anxiety symptoms and emotion regulation were also considered. Anxiety and emotion regulation are common among individuals with a history of childhood maltreatment. Working memory research has also

found both anxiety and emotion regulation ability to influence working memory performance, However, no known research has yet to address working memory, anxiety, and emotion regulation among females with and without childhood maltreatment experience.

Glossary of Terms

Child Maltreatment: Child maltreatment includes abuse or neglect of a child under the age of 18 years old (or the age specified by the state's child protection law).

Physical Abuse: Physical abuse is any bodily assault on a child by an adult or older individual that risks or causes injury.

Emotional Abuse: Emotional abuse includes incidents of verbally attacking a child's sense of self-worth or humiliating or demeaning a child by an older individual.

Sexual Abuse: Sexual abuse is any sexual contact or conduct occurring between a child under 18 years of age and an adult or older individual.

Physical Neglect: Physical neglect includes the failure to protect a child from harm or danger or to provide for a child's basic physical needed such as shelter, food, and clothing. Physical neglect is the most widely recognized and most commonly reported form of neglect.

Emotional Neglect: Emotional neglect is defined as a caregiver failing to meet a child's basic emotional needs. This type of neglect is difficult to document or substantiate due to the lack of physical evidence and the fact that it often occurs within the privacy of the home.

Working Memory: Working memory is a transient storage and procession component of memory that allows for the maintenance and storage of a limited capacity of information. It serves as an interface between perception, long-term memory, and action to aid in the human thought process.

Anxiety: Anxiety is a state of apprehension and tension.

Emotion Regulation: Emotion regulation is the processing that allows individuals to alter emotional experiences, expressions, and physiology to adapt appropriately to the changing environment.

CHAPTER II

LITERATURE REVIEW

Childhood Maltreatment and Working Memory: Considering the Influence of Anxiety and Emotion Regulation

About one in three college students report experiencing moderate to extreme childhood maltreatment (e.g. Duncan, 2000; Freyd, DePrince, & Zurbriggen, 2001; Gibb, Schofield, & Coles, 2009; Welsh, Peterson, & Jameson, 2017). College students with a history of childhood maltreatment are also known to have higher levels of attrition from school (Duncan, 2000). Some studies suggest that working memory, the ability to store and manipulate information in short term memory, differs in individuals with childhood maltreatment experience compared to controls (Lysaker, Meyer, Evans, & Marks, 2001; Shannon et al., 2011), although the reported research findings have been inconsistent. Childhood maltreatment experience is also linked to higher levels of anxiety (Carr, Severi Martins, Stingel, Lemgruber, & Juruena, 2013; Li, D'Arcy, & Meng, 2016), a symptom that may be exacerbated by the challenges of social, academic, and personal adaptation to college. Individuals with a history of childhood maltreatment show difficulty with emotion regulation (i.e. Cicchetti et al., 1991) and it may be that emotion dysregulation increases the risk for difficulty with anxiety. Given the importance of both emotion regulation and working memory to adaptation and achievement in school (Becker, Miao, Duncan, & McClelland, 2014; Crozier & Hostettler, 2003; Demetriou et al., 2014; Gumora & Arsenio, 2002), and the observed impairments in these domains in young

adults with a childhood maltreatment history, this study is designed to address working memory performance under various conditions of emotional arousal, while considering the influence of individual differences in anxiety and emotion regulation ability. Although many studies address these constructs independently, there are few studies examining the interaction of these constructs in emerging adults attending college.

The current literature addresses the domains of emotion regulation (Camras et al., 1996; Cicchetti et al., 1991; Kim & Cicchetti, 2010), anxiety (Green et al., 2010; Teicher & Samson, 2013; Westermair et al., 2018) and working memory (Masson et al., 2015) separately in studies of individuals with a history of childhood maltreatment. Although each of these constructs is measured independently in lab settings, in navigating everyday situations, such as in a classroom or dormitory, these processes and symptoms are likely to interact. For example, a classroom debate requires working memory to follow and update information during the discussion while processing emotional content in the classroom, and these processes may be altered for a student with high trait anxiety. However, no research was found that examined how working memory, emotion processing, and anxiety relate to each other in individuals with a history of childhood maltreatment. It was expected that college students reporting experiences with childhood maltreatment would have particular difficulties with working memory performance under conditions of heightened emotional arousal, and that individual differences in anxiety and emotional dysregulation would exacerbate these working memory impairments. In the following sections, childhood maltreatment is defined, and the common mental health outcomes are described. Implications of childhood maltreatment on working memory, anxiety, and emotion regulation are further discussed.

Childhood Maltreatment History in Emerging Adulthood

Definitions of Childhood Maltreatment

Researchers address child maltreatment using various operational definitions. Many institutions and government define child maltreatment as involving any one or more of the following: physical abuse, the intentional use of physical force on a child that could lead to physical injury; sexual abuse, attempted or completed sexual acts, contact, or exploitation by a caregiver; psychological abuse, intentional behavior of a caregiver that could be harmful or insensitive to a child's development or could lead to psychological or emotional damage; or neglect, the physical, emotional, medical or educational needs of a child are not met by the caregiver (Miller-Perrin & Perrin, 2013). Legal definitions of child maltreatment within the United States vary by state, as the Federal Government establishes a minimum standard for definitions allowing states to further define maltreatment individually. In general, physical abuse, neglect and psychological abuse definitions in the United States focus on injury outcomes for the child, leaving neglect and psychological abuse more ambiguous and more difficult to identify than physical abuse. Some researchers (e.g., Bernstein et al., 2003) deviate somewhat from CDC and legal definitions. Here *physical abuse* is defined as any bodily assault on a child by an adult or older individual that risks or causes injury, *physical neglect* as a caretaker's failure to provide for the basic physical needs of the child, *sexual abuse* as any sexual contact or conduct occurring between a child under 18 years of age and an adult or older individual (this definition does not limit the perpetrator to a caregiver, as in the CDC definition), *emotional abuse* as verbally attacking a child's sense

of self-worth or humiliating or demeaning a child by an older individual, and *emotional neglect* as a caregiver failing to meet a child's basic emotional needs.

From public opinion to the research community, there is little consensus on what constitutes maltreatment. While some researchers may follow more closely to the Center of Disease Control and Prevention definitions (De Bellis, Hooper, Spratt, & Woolley, 2009), others only consider aspects of abuse and exclude neglect (e.g. Miller et al., 2015), while others rely more on legal definitions and reported cases (e.g. Kirke-Smith, Henry, & Messer, 2014) or expand their scope to include witnessing violence in the home or community (e.g. Augusti & Melinder, 2013). For the purposes of this research, child maltreatment included self-reported physical abuse, sexual abuse, physical neglect, emotional neglect, and emotional abuse as defined by Bernstein and colleagues (2003) in an effort to devise a maltreatment group which includes the experiences of both abuse and neglect. In this study, childhood maltreatment was examined in a sample of college students. Since this maltreatment sample has obtained college status, it is possible that this sample may be more resilient than a clinical or community population. Also, these participants have self-selected into an environment requiring a specific degree of effective working memory performance to succeed. However, college students with a history of childhood maltreatment have still been shown to manifest difficulties, such as poor college adaptation, lower GPA scores (Welsh et al., 2017) and higher rates of attrition from college (Duncan, 2000) when compared to non-maltreated students.

Implications of Maltreatment for Maladaptive Function and Mental Health

Childhood maltreatment has been linked to many poor outcomes in adulthood. Research suggests adults with a history of maltreatment experience difficulties in their social and romantic relationships (Doyle & Cicchetti, 2017). College students with a history of maltreatment experience higher rates of psychopathology, most commonly including depression or anxiety, as well as health risk behaviors such as substance use and risky sexual behavior (Berzenski & Yates, 2011; Sun et al., 2008) and are less likely to remain enrolled in college (Duncan, 2000).

Poor mental health outcomes after childhood maltreatment have been well documented. The most prevalent psychopathologies among individuals with a history of maltreatment include depression, substance abuse, and anxiety disorders including posttraumatic stress disorder (PTSD). Individuals with a history of childhood maltreatment are also more likely to have an earlier onset of a mental disorder and more severe symptoms along with higher comorbidity, risk of suicide, and poorer response to treatment than those with the same diagnosis without a history of childhood maltreatment (Teicher & Samson, 2013). Self-reported childhood maltreatment is associated with the onset of nearly 30% of all psychiatric disorders (McLaughlin, Peverill, Gold, Alves, & Sheridan, 2015) and over half the cases of anxiety and depression (Li et al., 2016). Evidence exists for differing mental health outcomes based on the type of maltreatment experienced. A meta-analysis conducted by Carr et al. (2013) reported physical and sexual abuse along with unspecified neglect to be associated with mood and anxiety

disorders, while emotional abuse is associated with personality disorders and schizophrenia and physical neglect with personality disorders.

Depression, anxiety, and PTSD in adults with a history of childhood maltreatment has been a focus for many studies. Yet, many individuals with maltreatment experience do not meet criteria for a clinical disorder, yet still display trauma related symptoms. The literature suggests that evaluating current mental health symptoms by child maltreatment type is vital, as different patterns of symptom presentation have been found based on type of maltreatment experienced (e.g. Berzenski & Yates, 2011), but the research addressing differences across maltreatment types is limited. Moreover, neurological research reveals that brain areas that support emotional processing are linked to anxiety and these areas are highly interconnected with the area of the brain active during working memory processing, as discussed in the next section.

Neural Findings Associated with History of Childhood Maltreatment

Structural and functional brain differences have been identified after childhood maltreatment. The brain areas of interest for this research include the prefrontal cortex (PFC) and the amygdala. The PFC is associated with regulating cognitive and emotional processes as it is highly interconnected with other cortical and sub-cortical brain regions (Lysaker et al., 2001; Shannon et al., 2011). This brain structure is important for executive functions, including working memory, as well as appropriate social behavior and personality (Gazzaniga, Heatherton, & Halpern, 2016). The amygdala is a structure within the limbic system and is highly involved with processing emotional stimuli (Thompson, Lewis, & Calkins, 2008).

Structural differences in the prefrontal cortex (PFC) have been reported after maltreatment. Some results are conflicting, indicating either larger or smaller PFC volume in children with a history of maltreatment (Carrion, Weems, Richert, Hoffman, & Reiss, 2010; De Bellis et al., 2002). Researchers have theorized that child abuse later in childhood (age 14-16 years old) is more likely to be linked to a decrease in PFC volume (Carrion et al., 2010; McCrory, De Brito, & Viding, 2012). In college students reporting a history of maltreatment, reduced gray matter volumes in the medial PFC were found (Gorka, Hanson, Radtke, & Hariri, 2014). Adults who self-reported experiencing emotional abuse as children also had substantially reduced medial PFC. After reporting on significantly lower PFC volumes in individuals with a history of childhood emotional maltreatment, researchers emphasized these brain differences could influence emotion regulation (Harmelen et al., 2010) as well as cognitive ability.

As part of the limbic system, the amygdala processes incoming emotional information, especially threatening stimuli, and orients the cognitive and perceptual systems of the prefrontal cortex (PFC) to the emotionally salient material (Thompson et al., 2008). The amygdala processing of emotional stimuli in conjunction with the PFC input plays a key role in organizing risk assessment and anxiety (Russell, 2005). The processing of emotional stimuli in the amygdala and the communication of this information with the PFC is vital to the ability to regulate emotion.

Fearful facial stimuli are known to produce amygdala activity (Hariri, Tessitore, Mattay, Fera, & Weinberger, 2002). Individuals with a history of maltreatment show higher levels of amygdala activation to negative emotional stimuli than controls (Driessen et al., 2004; McLaughlin et al., 2015; Rauch et al., 2000; Shin et al., 2004).

Interestingly, when these individuals were asked to decrease their emotional response to the stimuli, greater activation of areas in the PFC were observed in the maltreatment group, but amygdala responses remained similar across groups for this condition (McLaughlin et al., 2015). This could indicate that the fear response can be reduced, but it appears to involve greater cognitive effort for those with a history of maltreatment. Individuals with emotion dysregulation after traumatic experiences have also shown greater ventromedial and dorsomedial PFC activation to fearful face stimuli (Powers et al., 2017); this may be indicative of a relationship between post-traumatic anxiety and difficulty with emotion management. As differences in emotion regulation and emotional processing have been found in individuals with a history of childhood maltreatment, the influence of anxiety becomes of particular interest as it is also linked to amygdala functioning.

Puetz and colleagues (2017) found individuals with a history of childhood maltreatment displayed lower connectivity between dorsal and ventral PFC regions. They also reported neurodevelopmental alterations in networks specific to working memory as well as in areas linked to regulation of affect. Individuals with lower connectivity between the amygdala and ventromedial PFC, who also reported stressful life events, reported more symptoms of anxiety and depression (Hanson, Knodt, Brigidi, & Hariri, 2015). These neurocognitive findings may help explain the relationship of working memory deficits and emotion regulation difficulties among individuals with a history of maltreatment in childhood (Puetz et al., 2017).

In review, the brain regions tied to emotion regulation and working memory show differences in structure and function after childhood maltreatment experience. These

impairments in neurocognitive mechanisms are associated with the regulation of emotion and cognitive interaction. Working memory has been found to be area of impairment among emerging adults with a history of childhood maltreatment. As the amygdala is an important brain structure to both emotion regulation and anxiety, emotion regulation in the context of childhood maltreatment will also be reviewed. This study examined working memory performance, particularly under conditions of heightened emotional arousal, consistent with the connectivity between the amygdala and the PFC, and the evidence of abnormalities in both regions that are correlated with childhood maltreatment.

Childhood maltreatment has many negative implications for adaptive functioning during emerging adulthood. Present neural childhood maltreatment evidence is consistent with the difficulties with the executive function of working memory, anxiety, and emotional regulation also observed after maltreatment. The next section addresses working memory, a cognitive ability necessary for many adaptive behaviors throughout life, and evidence of its impairment in individuals with a history of childhood maltreatment.

Childhood Maltreatment and Working Memory

Working memory (WM) is a transient storage and processing component of memory that allows for the maintenance and storage of a limited capacity of information. It serves as an interface between perception, long-term memory, and action to aid in the human thought process (Baddeley, 2003). Baddeley's (2003) theory of working memory includes the phonological loop, visuospatial sketchpad, and central executive. The phonological loop allows for temporary and limited storage for verbal information, which

can be refreshed with subvocal rehearsal. The visuospatial sketchpad is also considered to have temporary and limited storage but for visual, spatial, and object information. Both the phonological loop and the visuospatial sketchpad are linked to the central executive, the attentional controller, allowing both verbal and visual information to be processed together (Baddeley, 2003).

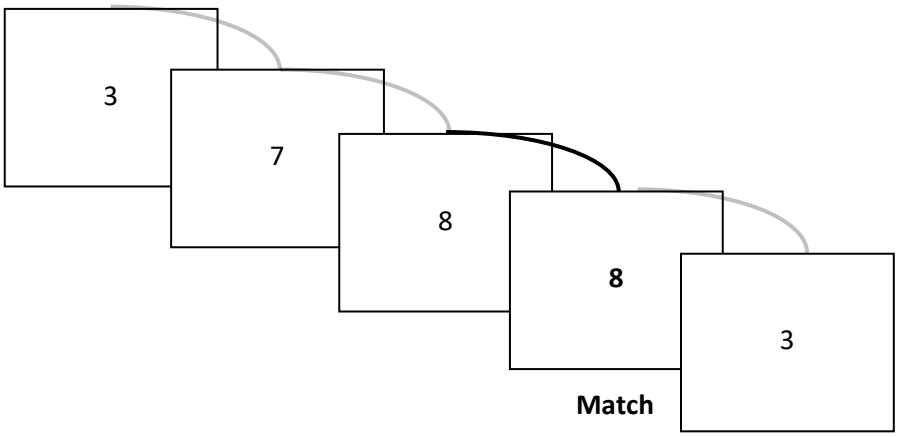
Working memory is vital to academic success and is necessary to execute all academic tasks (Best et al., 2011; Jacob & Parkinson, 2015). Currently there are conflicting reports of a working memory deficit for individuals with a history of childhood maltreatment, and evidence for anxiety-related deficits in working memory have also been reported. It is possible that the interaction of childhood maltreatment experience and current anxiety symptoms impact working memory performance, potentially explaining some of these conflicting findings, and the current study examined this interaction.

Working Memory Tasks

Due to the conflicting results of studies addressing childhood maltreatment and working memory ability, it is helpful to consider the types of tasks used to assess working memory. There are three main types of tasks used to assess working memory: simple span, complex span, and dynamic span tasks. Simple span tasks require participants to recall a list of stimuli, usually digits, in the order presented or in the reverse order they were presented. Simple span tasks are not always considered to address working memory ability as they only require storage and rehearsal to execute, but some areas of research, such as in anxiety and working memory, consider these tasks when addressing the working memory system (Moran, 2016). Complex span tasks combine a simple span task

with a second task, such as evaluating a sentence for truthfulness. This is done by alternating items to be remembered (such as in a simple span) with sentences to be evaluated, thus, requiring more controlled attention to recall span items after sentence evaluation. Dynamic span tasks also include a span of to-be-remembered stimuli, usually in the form of letters or digits. These tasks differ from simple and complex span tasks, due to the need to not simply recall the presented stimuli, but to continuously update the information throughout the task. For example, the N-back is a dynamic working memory task in which digits or letters are presented one at a time. In a 1-back version of the task, the participant is asked to respond to each presented stimulus based on whether it is the same stimulus just presented (1-back). For the 2-back version, each stimulus response is based on if it matches the stimulus presented two times previously (2-back). See Figure 4 for an example.

1-back



2-back

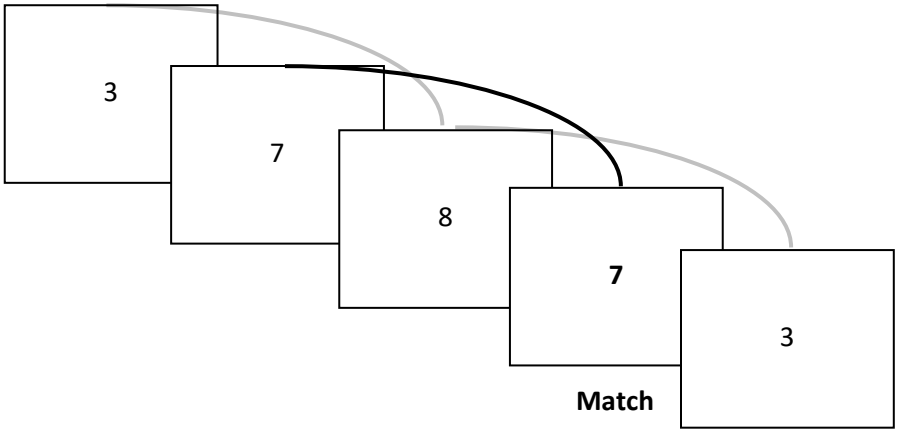


Figure 4. N back Examples

The N-back has recently become a preferred working memory assessment because it can easily be varied to address aspects of working memory load. It has also been adapted to assess spatial working memory (Shackman et al., 2006) by requiring participants to recall when a stimulus's location matches that of one presented *N* times previously. Others have included include emotional components, such as emotional faces, where the emotional expression of a face is matched (e.g. Levens et al., 2017). These emotional versions of N-back tasks allow researchers to examine how emotion interacts with working memory performance. The N-back task is ideal for this because stimuli can

easily be altered from traditional, neutral stimuli (in the form of letters or digits) to emotional stimuli (in the form of emotional faces or words). Also, the N-back provides both an accuracy score and a response time. Response time is valuable because it can be a more sensitive measurement of working memory processing, revealing differences not identified by accuracy scores (e.g. Levens et al., 2017; Levens & Gotlib, 2010). For these reasons, this study included two versions of an N-back task. One traditional N-back used neutral stimuli in the form of digits. The second used emotional faces, allowing for the interaction of working memory processing and emotion to be compared to the traditional N-back.

Working Memory Deficits in Adults with Childhood Maltreatment

Many cognitive domains have been investigated in individuals with childhood maltreatment histories. Some research has indicated that working memory has one of the strongest relationships with maltreatment experience. In a meta-analysis done by Masson and colleagues (2015), child maltreatment related to a negative impact on several cognitive domains as assessed with common tests (i.e. WISC-III & IV, WMS-III and Trail Making Test). While some studies report deficits in a wide range of cognitive ability, including executive function, learning and memory, processing speed, working memory, visuoperceptual function, and language (Vasilevski & Tucker, 2016), the Masson et al. (2015) meta-analysis found child maltreatment to have the strongest relationships with the cognitive domains of working memory, attention, and processing speed across age groups. In childhood, maltreatment had the biggest impact on working memory as evidenced by a large effect size. Moderate effect sizes were found for processing speed,

attention, and executive function (excluding working memory in this analysis). In adults, child maltreatment appeared to have a strong influence on attention, as the effect size only differed slightly from that seen in childhood samples. A smaller effect size was found for working memory, but it remained moderate, indicating that while the cognitive deficit decreased, it did persist into adulthood (Masson et al., 2015). Significant differences were also found in adults between maltreatment and controls for processing speed and executive function, but with smaller effect sizes than in child samples. Overall, child maltreatment showed the greatest impact on working memory, with the effect greater in childhood than adulthood.

However, studies of adults with a history of childhood maltreatment have yielded conflicting results in terms of working memory performance. Some studies have not seen significant differences between individuals with maltreatment and controls for working memory performance tested with tasks of arithmetic and digit span (Bremner et al., 1995; Bremner et al., 2004; Stein et al., 1997). Yet, Lysaker and colleagues (2001) and Shannon and colleagues (2011) found differences in performance between maltreatment and control groups with a letter-number sequencing task of working memory. While this leads us to question the difference between working memory tasks using arithmetic and digit spans vs. letter-number sequencing, we must consider that the studies not only differed in the working memory tasks used, but also in the samples of participants. Lysaker et al. (2001) and Shannon et al. (2011) found differences in samples with an average age in the 40s, while no differences were found with participants with an average age in the 30s (Bremner et al., 1995; Bremner et al., 2004; Stein et al., 1997). Therefore, the studies differ in both task type and average age of participants. It may be that discrepancies in the

research findings on childhood maltreatment and working memory reflect variations in methods employed in terms of working memory task, and samples tested (age, type of maltreatment experienced, age of maltreatment experience, and gender).

As working memory is linked to child maltreatment, it is not yet clear whether these differences found are specific to a working memory deficit alone, or a result of other impaired cognitive processes needed for working memory processing. For example, attention and processing speed deficits are both linked to childhood maltreatment and are utilized in many working memory tasks. It may also be that working memory ability interacts with other deficits linked to maltreatment, such as emotion regulation. Studies only finding working memory differences with tasks using arousing stimuli, such as emotional faces, suggest emotional control may interact with working memory performance (Caldwell et al., 2014; Kensinger & Corkin, 2003; Levens et al., 2017).

The current evidence for the relationship between childhood maltreatment and working memory is mixed. The use of multiple working memory tasks and varying sample characteristics may contribute to the lack of clarity for this relationship, but overall working memory difficulties appear in individuals with childhood maltreatment experience. Research has not yet addressed the possible impact anxiety and emotional regulation may have on working memory in individuals with a maltreatment history. In what follows, empirical research which has attempted to address some of the linkages of these different domains will be discussed.

Childhood Maltreatment, Anxiety, and Working Memory

History of Child Maltreatment and Anxiety

Green et al., (2010) reported that childhood adversity predicted 32.4% of the variability in anxiety disorders. Individuals with an anxiety disorder and a history of childhood maltreatment are at significantly higher risk for concurrent major depression, show impairments in social functioning, have higher state and trait anxiety scores, higher chronicity and symptom severity, and poorer quality of life (Teicher & Samson, 2013). In a recent study, Westermair and colleagues (2018), found an expected relationship between all types of childhood maltreatment and PTSD. However, when looking at other anxiety disorders (such as social phobia and panic disorder) relationships were found for all types of maltreatment except sexual abuse.

Newbury and colleagues (2018) also found stronger relationships between retrospective self-reports of childhood maltreatment experience and anxiety than prospective reports from parents and/or researchers. In fact, the relationship between prospective reports of maltreatment and symptoms of anxiety did not remain among individuals who did not also self-report maltreatment experience. Although anxiety is commonly reported among individuals with a history of childhood maltreatment, the relationship may be limited to individuals who either have the memory of their experiences or willingness to self-report.

The experience of multiple types of maltreatment is associated with more severe anxiety, and emotional abuse and neglect, specifically, indicate a risk for social anxiety disorder (Teicher & Samson, 2013). Childhood adversity has predicted anxiety related

impairment at work, in social relationships, and household maintenance (McLaughlin et al., 2015). The anxiety experienced after childhood maltreatment appears to further impact mental health (beyond anxiety), put a strain on social relationships, and impair features of everyday functioning.

Anxiety linked to childhood maltreatment is a mental health symptom that influences many aspects of typical adult adaptive behaviors ranging from work performance to social relationships. Much like the presence of anxious symptoms, difficulty with working memory, also influences many behaviors necessary for everyday living. Anxiety and working memory are not typically addressed together in maltreatment research, so the following review first discusses current research on anxiety and working memory. Understanding the relationship between anxiety and working memory is important before investigating how these two constructs interact in individuals with a history of childhood maltreatment.

Anxiety and Working Memory

In a large meta-analysis addressing the relationship between anxiety and working memory performance, Moran (2016) found anxiety to relate to poorer working memory across 117 samples. While moderators such as age, trait vs. state anxiety, and worry vs. arousal were not found to be significant, anxiety symptom severity was found to be a significant moderator in both clinical and subclinical samples. The type of span task (simple, complex, or dynamic) did not significantly alter the association between anxiety and working memory; however, differences were found based on the domain of the span task (visual, phonological, and spatial). Phonological and spatial tasks of working memory were negatively associated with anxiety, but no association was indicated

between visual working memory and anxiety. Therefore, anxiety appears to interact with most working memory abilities, yet visual working memory is not altered by anxiety.

A working memory deficit has been linked to specific PTSD symptomology. Looking at a wide scope of trauma experience, Bomyea and colleagues (2012) investigated how working memory capacity related to three PTSD symptom clusters, hyperarousal, re-experiencing, and avoidance, in a non-clinical group of college students (meaning these college students displayed some PTSD symptoms but did not reach clinical criteria for a diagnosis of PTSD). Bomyea et al., (2012) assessed working memory capacity with a computerized Operational span (O-span) task, where a letter was presented before a completed math equation. Participants were asked to assess if the math problem was correct and at the end of each set (2 to 6 problems) they were asked to identify which letters were presented in the set. O-span performance was found to negatively correlate with re-experiencing symptoms, but significant relationships were not found for symptoms of hyperarousal or avoidance (Bomyea et al., 2012). Ross and Kearney (2017) found working memory, along with negative cognitions about self, dissociation, IQ, and posttraumatic cognitions, predicted the PTSD symptom of hyperarousal. These results were found in youth (age 7 to 18) from the Department of Family Services (DFS). Working memory was assessed with the Wechsler Intelligence Scale for Children, fourth edition (WISC-IV), which included Digit span, Picture span, and Letter-number sequencing.

Individual differences in anxiety and negative mood have been found to covary with working memory performance. Derakshan and Eysenck (1998) found that individuals who identified themselves as highly anxious with a self-report measure

displayed a slower response times in a verbal reasoning task and a memory task with higher working memory loads. Ikeda, Iwanaga, and Seiwa (1996) investigated individuals with high- and low-test anxiety. Here, highly anxious subjects displayed longer reaction times on a verbal memory task than the less anxious comparison group. The high-test anxiety participants also reported feeling more worried and more cognitive self-concern than the low-test anxiety group. Supporting the idea that worry consumes capacity in the phonological loop, but not the visuospatial sketchpad of working memory, the differences were limited to the verbal task and were not found in the spatial memory task (Ikeda et al., 1996). These findings are helpful to child maltreatment researchers, and relevant to this study, as it suggests that anxiety could be a possible moderator when considering the impact of childhood maltreatment on working memory.

Lavric and colleagues (2003) addressed if the negative effect of mood, rather than trait anxiety, influenced spatial working memory differently than verbal working memory. The researchers influenced mood with the threat of electric shock during a working memory task (verbal and spatial n-backs) and measured the effect of the threat with heart rate and self-report of anxiety, excitement, fear, sadness, and arousal. They found that individuals did not perform as well in the threat condition as they did in the safety (no threat of shock) condition. Also, participants reporting higher levels of anxiety displayed higher heart-rate differences (between threat and safety conditions) and were more impaired on the spatial working memory task. The authors also noted that substantial individual differences were found in emotional reaction to the emotion induction (threat of shock; Lavric et al., 2003). While these differences were controlled for, the authors did not speculate as to the cause of differences in emotional response. A

variety of life experiences, such as the experience of childhood maltreatment versus no maltreatment, may contribute to the variation in emotional response after a stressor is introduced. It is possible that individuals with a history of childhood maltreatment have a more anxious response to threat stimuli, which may further influence working memory performance.

Our own ongoing research consistently indicates that participants with a childhood maltreatment history self-report higher levels of anxiety than those without maltreatment experience. In our own pilot research, we have also found conflicting results for a general working memory deficit in individuals with maltreatment, as results have differed based on working memory task used (differences were found with the N-back, but not with Letter-number sequencing). Even as working memory, attention, and processing speed are the most commonly reported deficits associated with childhood maltreatment (Masson et al., 2015), other studies have only found differences in working memory performance when the task utilized emotional stimuli (e.g. Caldwell et al., 2014; Kensinger & Corkin, 2003; Levens et al., 2017). This study to examined working memory performance in college students under both neutral and emotionally arousing conditions. While, there is strong evidence that anxiety negatively impacts working memory performance; this study examined anxiety and maltreatment experience might interact to produce working memory deficits in a sample of college students with a history of childhood maltreatment. In addition to examining anxiety, the broader category of emotional regulation is another area of deficit associated with a history of childhood maltreatment. Next, research that has linked emotion dysregulation to both childhood maltreatment and working memory is discussed.

Childhood Maltreatment, Emotion Regulation, and Working Memory

Aldao (2013) defines emotion regulation as the processing that allows individuals to alter emotional experiences, expressions, and physiology to adapt appropriately to the changing environment. Emotion regulation includes the ability to understand and accept one's emotions, control impulsive behavior, initiate goal-directed behavior while experiencing unpleasant emotions, and effectively utilize emotion regulation strategies (Gratz & Roemer, 2004). Many disorders, such as anxiety, are characterized by the lack of ability to adapt emotionally to the environment. A better understanding of the emotional regulation in individuals with a history of childhood maltreatment could help us better understand the symptoms, clinical or sub-clinical, experienced after negative childhood experiences. In the context of this study, increased emotional arousal is expected to interfere with working memory performance particularly in individuals with a history of childhood maltreatment, and those with higher self-reported levels of anxiety and emotion dysregulation.

Emotion Regulation Deficits and Childhood Maltreatment

Difficulties with emotion regulation have been observed after child maltreatment experience (Cicchetti et al., 1991) and relate to social, behavioral, and mental health difficulties. Individuals who experience childhood maltreatment are likely to experience overwhelming emotional arousal but are less likely to receive support and scaffolding to help them learn how to regulate these negative emotions (Camras et al., 1996 for a review). In children who experienced maltreatment, emotion regulation has been linked to both internalizing and externalizing symptoms as well as peer acceptance (Kim &

Cicchetti, 2010). The relationship between emotion regulation ability and peer acceptance appears to continue into adulthood, as reported by Lopes et al., (2005). Oshri, Sutton, Clay-Warner, and Miller (2015) found emotional and sexual abuse to relate to emotion dysregulation, as well as risk behaviors, in college students. Emotion dysregulation has been found to mediate the relationship between child maltreatment and psychopathology in adults (Jennissen, Holl, Mai, Wolff, & Barnow, 2016).

Some researchers have begun to include emotional stimuli (e.g., faces depicting different emotions) in various cognitive tasks to address how emotion regulation may interact with cognitive abilities. For the purposes of this review, the relevant cognitive findings are discussed. In a study of women with high and low levels of child abuse, Caldwell and colleagues (2014) considered neuroimaging evidence of amygdala hyperactivation and hypoactivation of the medial prefrontal cortex (MPFC) in individuals after trauma (Etkin & Wager, 2007; Shin & Liberzon, 2010 for reviews). Caldwell et al. (2014) used a Stroop task with faces and words including non-emotional and emotional words. This task is considered to activate both the amygdala and the MPFC. The emotional face stimulus activates the amygdala. Regions of the MPFC, specifically the dorsal anterior cingulate (dACC) are known to be active for cognitive and emotional processing necessary to resolve conflict displayed within the Stroop task (Caldwell et al., 2014). No group differences were found for the comparison task using neutral faces and gender words (male and female). However, when the task included emotional faces and words (fearful and neutral) women who reported high levels of childhood abuse showed poorer adaptation as they were slower to correctly name the emotion in the incongruent fearful face trials as compared to women who reported low levels of childhood abuse.

This group difference was only found for incongruent fearful faces, as both the high abuse and low abuse groups performed similarly with neutral face stimuli as well as with congruent trials. The low abuse group also showed the expected faster reaction times when an incongruent stimulus preceded an incongruent trial. The high abuse group had slower reaction times on these trials. In this cognitive task, individuals with more extreme child abuse experiences showed performance differences only for the emotional stimuli condition. This study provided interesting results of an impaired cognitive ability in women with high childhood abuse experience only when emotional (fearful) stimuli were present (Caldwell et al., 2014). In addition to cognitive flexibility, emotional stimuli may also decrease working memory, a question that was explored in the current study by incorporating face stimuli expressing various emotions, including fear, into a working memory task.

Individuals with a history of child maltreatment often experience emotion dysregulation, which is linked to peer relationships, risk taking behaviors, as well as poorer psychological health. These issues with emotional regulation may contribute to poor college adaptation and achievement, and therefore are important to examine in emerging adults. The next domain discussed, the impact of emotion regulation on working memory, has been shown to be linked to academic performance in college (Carretti, Borella, Cornoldi, & Del Beni, 2009), and thus is a primary focus of the current study on the negative sequelae of childhood maltreatment in emerging adults.

Emotion Regulation Within Working Memory Tasks

The influence of emotional stimuli on working memory has been addressed in many studies, yet it is still difficult to decipher a clear relationship. Researchers approach each study on emotional stimuli and working memory from varying perspectives. For example, Levens and Phelps (2008) investigated proactive interference recovery in working memory, defined as the ability to limit the interference of information no longer relevant to the processing of currently relevant information for the current task. They investigated this phenomenon with working memory tasks utilizing emotional words and arousing pictures. They found emotional stimuli to reduce interference, indicated by faster reaction times, when compared to neutral stimuli. Kensinger and Corkin (2003) found slower reaction times to fearful faces when compared to neutral faces in an altered version of the N-back task. Accuracy differences were not found on tasks utilizing neutral and negative words or neutral, positive, and negative pictures of various scenes (animals, people) in types of working memory tasks which only produce accuracy scores (self-ordered pointing, backward word span, and alphabetical word span). However, the N-back utilizing emotional faces which produced response time as well as accuracy scores did find significant results, making this version of the N-back task better suited for assessing the possible influence of emotion on working memory.

Gan, Yang, Chen, Zhang, and Yang (2017) investigated the relationship between cognitive reappraisal ability (a strategy used to interpret emotional information and alter the emotional significance of the circumstances) and high versus low working memory loads. Differences in accuracy were, as expected, found between working memory loads, with low working memory loads relating to higher accuracy scores. Differences were not

found between neutral and negative reappraisal conditions. However, differences in response times did reveal faster responses to the neutral reappraisal condition than to the negative reappraisal condition. The authors suggest that neutral reappraisal successfully reduced the effect of negative emotions on task performance while working memory performance suffered during the negative reappraisal condition (Gan et al., 2017).

A contrasting study by Jackson, Linden, and Raymond (2014) investigated the influence of emotional stimuli on the encoding and retrieval mechanisms of working memory by presenting emotional stimuli during the study (encoding) phase or the retrieval (test) phase of a face identification task. They reported better working memory performance when angry faces were present at encoding (while studying stimuli). Performance on a visual working memory task was enhanced when angry, but not when happy, faces were presented during the study portion of the task. The emotional stimuli did not show a difference when it was presented at the test portion of the task, indicating that encoding, but not retrieval, was influenced by the emotional stimuli. It could be argued that the "studying" phase of this study required working memory while the "test" phase relied more heavily on long-term memory, leading these results to indicate that working memory is more sensitive to the influence of emotional content.

The effect of emotional stimuli on working memory is not clear. Research has indicated that the relationship between working memory and emotion eliciting stimuli may reduce interference (Levens & Phelps, 2008), slow down reaction times (Kensinger & Corkin, 2003), or be sensitive to working memory load (Gan et al., 2017). However, there appears to be preliminary support for exploring the impact of emotional stimuli on working memory performance. This research would be especially of interest among

childhood maltreatment populations. Also, response time, as opposed to accuracy, appears to be the more sensitive measure for examining the impact of emotion manipulations.

N-Back Tasks Manipulated with Emotion-Related Stimuli

The adequate response and adaptation to emotional stimuli in the environment requires multiple mental processes. One necessary mental process in this procedure is updating, an executive function considered necessary for working memory, as it allows for contents of working memory to be modified based on the change and relevancy of current information (Morris & Jones, 1990). This study utilized an adapted version of the N-back task, which required updating to properly complete. Pe and colleagues (2015) used a similar N-back adaptation. They suggested that the ability to alter the contents of working memory when presented with new information is necessary to properly react to and then recover from emotion-evoking situations. Therefore, effective updating in working memory allows for the adaptive response to a threating stimulus (such as a fight or flight response) as well as the decrease in reactivity when the stimulus no longer poses a threat. The failure of updating ability would lead the threatening stimulus to continue to elicit a threat response even when it is no longer necessary. Because of this, it has become a process of interest in research addressing emotion regulation and working memory as updating is critical to dealing with arousing and threat stimuli and may be particularly salient for individuals with a history of childhood maltreatment.

The reaction to and recovery from emotional stimuli requires emotion regulation, which refers to how individuals experience and express emotion as well as the processes which influence which emotions they experience and when they experience them (Gross,

1998). Studies have shown a relationship between individuals' ability to update working memory and their ability to regulate emotional responses to disgusting stimuli (Schmeichel, Volokhov, & Demaree, 2008) and negative emotional stimuli (McRae, Jacobs, Ray, John, & Gross, 2012). That is, individuals exhibiting better updating ability in working memory displayed less emotional reactivity to negative stimuli when instructed to limit their emotional reactions.

Considering these elements of emotion regulation and updating in working memory, Pe and colleagues (2015) investigated if updating ability was related to emotion reactivity as well as to the recovery from emotion-eliciting events. To address updating ability and emotion reactivity and recovery, participants viewed film clips with varying valence (positive, neutral, and negative), then rated their emotional responses after each clip (reactivity to the clip) and after a rest period (recovery from the clip).

The ability to update emotional information was measured with an emotional 2-back task, a variation of the N-back task commonly used to assess working memory and updating ability. The authors altered a traditional N-back (typically using letters or numbers) by utilizing emotional words as stimuli. Participants judged if the valence of the current word matched the valence of the word two trials previously (2 back). Because participants need to remove previously relevant emotional information and replace it with new incoming information, the task requires a specific ability to continually update emotional information in working memory (Pe et al., 2015).

Better updating ability was related to greater emotion reactivity to watching negative film clips as well as a greater recovery from negative emotions during the rest period after negative film clips (Pe et al., 2015), differing from studies where participants

were instructed to limit the emotional reaction (McRae et al., 2012; Schmeichel et al., 2008). Pe and colleagues (2015) used 2-back accuracy scores as a measure for updating ability, but accuracy and response time (RT) were not otherwise addressed. While overall 2-back accuracy scores did relate to the negative response to and recovery from negative film clips, accuracy based on the valence of N-back stimuli were not compared. Therefore, this study did not reveal an influence of updating working memory ability to emotional content within the working memory task (the influence of emotion within the working memory task was not analyzed). This study analyzed both accuracy scores and response times based on five different emotions included within the N-back task, allowing for the investigation of the possible influence of emotion.

Kensinger and Corkin (2003) aimed to identify the possible impact emotional stimuli may have within a working memory task by using various working memory tasks. Their tasks included an N-back, along with other working memory tasks, with negative and neutral stimuli and they analyzed performance based on valence. Using multiple tasks that assess working memory, including self-ordered pointing, word spans, and the N-back, emotional content was added in the form of varying stimuli (pictures of snakes or injured people, negative or taboo words, or pictures of fearful faces) to alter the tasks from neutral to emotional. Accuracy on the tasks did not differ based on neutral and emotional conditions. The only task to show differing results between neutral and emotional versions was the N-back with reaction times. The N-back task results indicated slower responses for fearful faces than for neutral faces, specifically when emotion and neutral trials were integrated rather than presented in separate blocks of the task (Kensinger & Corkin, 2003). The authors speculated that the differences in reaction times

for the integrated versus the separate blocked conditions occurred because the separate blocked tasks (one block neutral, one block emotional) caused a weakened arousal to emotional stimuli as participants started to expect the emotional faces or negative words. It is possible that an adaptation to emotional stimuli occurred over the presentation of many trials. In this study, the emotional N-back integrated the different types of emotional stimuli.

Only the N-back tasks provided significant results between neutral and emotional tasks in the study done by Kensinger and Corkin (2003). This may be due to the fact that differences in response time, rather than overall accuracy, were found and only the N-back task recorded response time. It is important to note that response time was sensitive enough to detect within group differences for a sample of 30. However, other differences were also present, as the N-back task was the only working memory task to utilize emotional faces as emotional stimuli (rather than words or pictures of animals, etc.). It is possible that the facial stimuli were a factor in task outcome, as the N-back utilizing neutral and negative words did not show differing results on emotional content in accuracy or response time. It should also be noted that the N-back task required a greater amount of updating than the other working memory tasks used in this study. The N-back task with an emotion face manipulation was used in this study and examined the influence of emotion dysregulation, anxiety, and childhood maltreatment experiences.

N-Back Performance, Emotional Dysregulation, and Stressful Life Experiences

Given that the N-back provides measures of accuracy as well as response time and can be altered to include emotional stimuli, it is a useful task when assessing the

influence of emotional stimuli on working memory performance. Addressing the influence of emotion on working memory is of particular interest in a childhood maltreatment sample as maltreatment has been linked to difficulties with emotion regulation and working memory. Integrating an emotional N-back with groups of college students varying in adversity experience (distant, recent, and none), Levens et al., (2017) investigated how emotional updating differed by adversity experience. The researchers utilized the Trauma History Questionnaire (THQ), which does not specifically assess for childhood maltreatment. However, the way the THQ was used to assess for adverse experiences in the participants' past, childhood maltreatment experiences may have been included within the distant adversity group. Individuals who had experienced a traumatic event within the last six months, and none previously were included in the recent adversity group. Any individual with a traumatic experience more distant than six months was included in the distant adversity group, even if they reported a more recent adverse experience. In addition to adding emotional stimuli to the N-back task, they also identified match-set trials (when the current expression matches the one presented two trials earlier, requiring a "Match" response), break-set trials (the trials following a matched set which do not match, requiring a break from the previous match set), and no-set trials (trials that are not a match-set and do not immediately follow a match-set trial). The interaction of emotion and trial type provided interesting results.

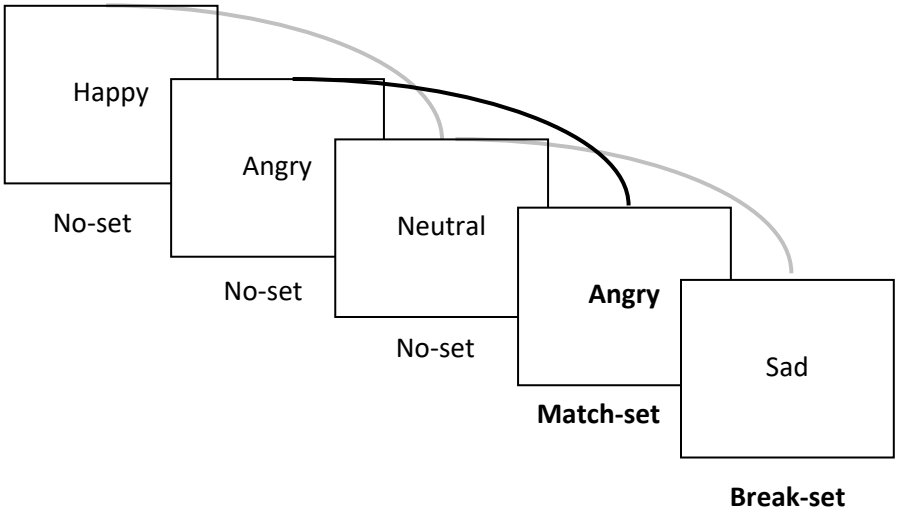


Figure 5. Trial Set Example

They found that each adversity group displayed unique response times to emotional stimuli. The distant adversity groups displayed the fastest response time, the recent adversity the slowest, with the no adversity group response time falling in between. The recent adversity group also had significantly lower accuracy scores than the other two groups. Results were also reported for trial type. Match-set trials with happy and neutral expressions had higher accuracy rates, whereas in break-set and no-set trials higher accuracy was found with fearful and neutral faces. Response times also varied based on trial type and emotion, as match-set and no-set trials were faster for happy stimuli when compared to neutral, angry, fearful, and sad stimuli. In break-set trials, happy faces yielded significantly slower response times (Levens, et al., 2017). Although the interaction between trial type and emotion was analyzed, possible main effects of trial type or emotion were not reported. As with the Kensinger and Corkin (2003) study, these results suggest that reaction time is an important measure as the speed of processing and responding during this task differed by type of emotional stimuli. The emotional findings of this study were based on type of emotional stimuli used (i.e. happy vs. fearful) as well

as different performances based on distance (in time) to adversity experienced. Recognizing the distant adversity group had accuracy scores similar to the no adversity group, the authors speculated that it may be possible for the recent adversity group to improve on emotional updating with time and experience. They also acknowledged that posttraumatic stress symptoms are reportedly highest immediately following the traumatic event and decrease over time (Hong et al., 2014; Tsai, Sippel, Mota, Southwick, & Pietrzak, 2016). The question of current symptomology and emotional working memory task performance becomes more compelling as the authors report that the distance adversity group reported a similar number of recent adversity events as the recent adversity group (who reported no distant adversity). That is, the distant adversity individuals also reported experiencing recent adversity and higher stress levels than those with only recent adversity, but still displayed better performance in accuracy and faster response times in the emotional working memory task. This surprising result could reflect an adaptation to continued adversity. Yet, it is difficult to truly discern the cause among an adversity sample, as distant adversity would include child maltreatment as well as events such as losing a family member, being in a natural disaster, or experiencing a home invasion. By examining child maltreatment specifically, this study aimed to more clearly address the possible influence of emotional stimuli on working memory performance in adults.

The current research indicates that neutral faces do not influence working memory performance (Caldwell et al., 2014; Kensinger & Corkin, 2003), and while a range of emotion faces have been included in some studies (e.g. Levens et al., 2017 used happy, neutral, fearful, angry, and sad) some research only addresses neutral and fearful

stimuli (e.g. Caldwell et al., 2014; Kensinger & Corkin, 2003). In addition, only one study has examined the possible influence of emotion on working memory in a limited range of trauma and adversity experiences (Levens et al., 2017). Childhood maltreatment has not yet been specifically addressed concerning the influence of emotional stimuli in working memory. Current symptoms experienced, such as anxiety, often remains unassessed. It should be considered that the influence of a traumatic event on mental health may be a contributing factor in how emotion interacts with one's working memory ability.

Purpose and Hypotheses of the Study

Anxiety and emotional dysregulation have been identified as areas of concern for many individuals who report histories of childhood maltreatment. Both of these factors have been found to interfere with working memory performance. The goal of this study was to examine the performance of college students who differ in childhood maltreatment history on working memory tasks manipulated in terms of emotional arousal, and to investigate how individual differences in emotional dysregulation and anxiety interact with maltreatment history to predict working memory performance.

Research Questions

Q1 Are individuals with a history of childhood maltreatment influenced by emotional stimuli in a working memory task differently than individuals without a maltreatment history?

H1 The CM group will exhibit poorer performance (longer RT and higher errors) on the emotion N-Back than Controls, with no difference for the Number N-Back.

Q2 Among individuals with a history of childhood maltreatment, does anxiety moderate the relationship between childhood maltreatment and working memory performance?

H2 CM participants with higher anxiety (the high anxiety subgroup) will exhibit relatively poorer performance on the emotion N-Back as compared to the Comparison Group with high and low anxiety.

Q3 Among individuals with a history of childhood maltreatment, does emotion dysregulation moderate the relationship between childhood maltreatment and working memory performance?

H3 CM participants with higher Emotion Dysregulation (the high emotion dysregulation subgroup) will specifically exhibit relatively poorer performance on the emotion N-Back as compared to the Comparison Group with high and low emotion regulation.

CHAPTER III

METHOD

This study included a descriptive comparative research design. The population of interest was young adults with a history of childhood maltreatment with the goal of investigating the influence of emotional content on working memory performance. This study also examined the degree to which anxiety and emotional dysregulation interacted with childhood maltreatment history to predict working memory performance both with and without emotional stimuli. Prior to running this study, the University of Northern Colorado's (UNC) institutional review board (IRB) reviewed and approved this study's measurements and procedures.

Participants

The final sample for this study included 94 university students. Initially, 114 students participated in this study, and 20 of whom were removed from the data set based on the exclusion criteria described below. To limit confounding variables, only female participants were recruited. Female college students have a higher risk of being exposed to trauma (Read, Ouimette, White, Colder, & Farrow, 2011). Our own research has revealed gender differences in childhood maltreatment and symptomology reporting. Other research has displayed similar differences in reporting based on gender (MacMillan et al., 2001). For example, gender might impact the experience and reporting of childhood maltreatment history as well as rates of anxiety and emotional dysregulation

(Bernstein, Ahluvalia, Pogge, & Handelsman, 1997; Feingold, 1994). It is possible that the associations between the individual difference variables and working memory differ between males and females. Our college sample typically has a 3 to 1 ratio of females to males and a much larger sample would be required to adequately examine gender differences. Exclusion criteria included students under the age of 18 or over the age of 30 at the time of the study's screening, female, a low validity score on the childhood trauma measure described below), missing responses on survey measures, or a N-back score two standard deviations below the mean. Seven participants were excluded based on gender identification, two based on CTQ validity scale, one for missing survey responses, and ten based on N-back scores two standard deviations lower than the average score.

Participants were recruited via two methods. Some participants were recruited through the School of Psychological Sciences Study Pool and given course credit for participation. Others were recruited through other psychology classes or posted flyers and given a gift card for their participation.

Table 1

Demographics of Sample and CM Groups

	Sample Mean	Sample SD	Sample Minimum	Sample Maximum	CM Mean	Comparison Mean
Age	19.06	1.14	18	23	18.84	19.26
Year in School	1.57	0.85	1	4	1.47	1.66
SES	11.3	3	4	16	10.80	11.76
1st Generation %	41				55	30

Note: Age is reported in years. Year in school is reported by college status (Freshman = 1, Sophomores = 2, Juniors = 3, Seniors = 4. SES is a numerical score based on mother's highest level of education. 1st Generation college student is based on percentage of group reporting to be first generation.

Participants were assigned to the childhood maltreatment group (CM) based on the CTQ scores. Individuals with one or more scale score in the moderate range or higher were included in the childhood maltreatment group. In the final sample, 47% of participants self-reported moderate or higher degrees of childhood maltreatment (See Table 2 for details on self-reported maltreatment). Participants did not significantly differ on most demographic measures, but the childhood maltreatment group did have a higher percentage of first generation college student status ($X^2_{(1, N=94)} = 5.81$, $p = .016$). Analyses were run with first generation college student status as a covariate but including first generation in the analysis did not alter the results. Therefore, the results are reported from the analyses without this covariate.

Participants were assigned to high or low anxiety groups by a sample median split based on a composite score from the anxiety scales from the TSC and SCL-90 measures (described below). Group assignment for high and low emotion dysregulation were based on a sample median split for total Difficulties in Emotion Regulation Scale (DERS) score.

Table 2

Sample frequency and percentage of self-reported maltreatment

Maltreatment Type	Sample Frequency	Percentage
Emotional Abuse	31	33%
Physical Abuse	15	16%
Sexual Abuse	19	20%
Emotional Neglect	16	17%
Physical Neglect	24	26%
Child Maltreatment	44	47%

Measures

Self-Report Measures

Demographics. Demographic information was collected to describe sample and group characteristics. Collected demographic information included age, ethnicity, country origin, year in school, and mother's highest level of education.

Childhood Trauma Questionnaire (CTQ; Bernstein et al., 2003). The CTQ is a 28-item questionnaire which includes five scales: physical abuse, emotional abuse, sexual abuse, physical neglect, and emotional neglect. Each scale consists of five items with five possible responses ranging from "Never" to "Often." The CTQ also includes three validity items to help identify unusually positive responses on this measure. Each maltreatment scale score determines if maltreatment was none to minimal, low to moderate, moderate to severe, or severe to extreme. These ranges differ for each scale and were established by Bernstein et al. (2003) and Bernstein and Fink (1998). Group membership was determined using the ranges for each scale and individuals with a score within the moderate or above range on one or more scales were included in the child maltreatment group. Scale scores for moderate to extreme maltreatment are as follows: emotional abuse with a score of 13 or higher; physical abuse with a score of 10 or higher; sexual abuse with a score of 8 or higher; emotional neglect with a score of 15 or higher; physical neglect with a score of 10 or higher. The CTQ includes a validity scale based on three items to detect highly positive responses. One item states "I had the perfect childhood." Any participants with low validity scores (scores of 3 or 4), indicating a pattern of highly positive responses, were not included in the sample. The CTQ has good internal consistency (.63-.95) in both community (Bernstein et al., 2003) and clinical

(Bernstein & Fink, 1998) samples, as well as a range of criterion-related validity (.50-.75). It has also demonstrated a Cronbach's alpha of .95 for the total scale and good test-retest reliability (intraclass correlation = .88).

Trauma Symptom Checklist (TSC-40, Elliot & Briere, 1992). The TSC-40 is a 40 item self-report instrument which evaluates symptoms associated with childhood or adult traumatic experiences. It consists of six subscales: Anxiety, Depression, Dissociation, Sexual Abuse Trauma Index, Sexual Problems, and Sleep Disturbance. The anxiety scale includes nine items. Participants were asked to rate the frequency of each symptom over the prior 2 months. Response options range from 0 (never) to 3 (often). For participants who endorsed a trauma history, the TSC-40 is a measure used to briefly screen for the presence of symptoms associated with posttraumatic stress disorder (PTSD) and gauge the participants' current levels of distress. The TSC has demonstrated internal consistency (.62-.77; Elliot & Briere, 1992). In the current study, the internal consistency for the anxiety scale on this measure was .73 and considered to have fair reliability.

Symptom Checklist-90-Revised (SCL-90, Schwarzwald, Weisenberg, & Solomon, 1991). The SCL-90-R is a 90 item self-report measure of mental health symptoms. Each item is rated on a 5-point scale of distress. Sub-scales include 9 symptom dimensions of somatization, obsessive-compulsive, interpersonal-sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation and psychoticism. The anxiety sub-scale, which includes 10 items, were used in this study. Internal consistency for the sub-scales range from .77 to .90. The test re-test reliability for the whole measure

has been reported as .91. In the current study, the internal consistency for the anxiety scale on this measure was .86 and considered to have good reliability.

Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004). DERS is a 36 item self-report measure assessing emotion regulation. Participants indicate how each item applies to them with a number between 1 (almost never; 0-10%) and 5 (almost always, 91-100%). Items include statements such as "When I'm upset, I take time to figure out what I'm really feeling" and "I have difficulty making sense out of my feelings." This measure includes six subscales including nonacceptance of emotional responses, difficulty engaging in goal-directed behavior, impulse control difficulties, lack of emotional awareness, limited access to emotion regulation strategies, and lack of emotional clarity. Each sub-scale is the sum of five to eight scale related items. DERS has demonstrated a Cronbach's alpha of 0.97 for total score and alpha values for the subscales ranged from 0.88 to 0.95 (Bardeen, Fergus, & Orcutt, 2012). For the current study, the DERS internal consistency was .94, which is a sign of good reliability.

Revised Reactions to Research (R2R; Kassam-Adams & Newman, 2002). The Revised R2R is a 12-item survey (see Appendix D for the complete survey) which is a shortened version of the full Reactions to Research Participation Questionnaire. Items give participants the opportunity to rate their reactions to participating in the study. Item responses can vary from "Strongly Disagree" to "Strongly Agree" on a five-point Likert scale. Examples of the items included: "I gained something positive from this experience"; "This research raised emotional issues for me that I had not expected"; "I believe this study's results will be useful to others". This survey was used to gauge each participant's reaction to the sensitive surveys included in this study. It also aided

researchers in properly executing the Participant Well Being Protocol (included in Appendix E).

Working Memory Measures

Emotional N-Back. The emotional N-back task is identical to the Traditional N-back task with two exceptions: stimuli are emotional faces and participants are asked to identify matched emotions (rather than matched digits). The stimuli are from the male NimStim Set of Facial Expressions and have been reported to have high validity and reliability as the expressed emotions have been accurately identified and displayed high intra-participant agreement (Tottenham et al., 2009). Only male faces were included in this task due greater difficulty identifying emotions in female faces when the task was pilot tested. Emotional expressions of happy, sad, angry, fearful, and neutral were included in this task, following the procedures used by Levens et al., (2017). Stimuli included emotion expressions from six male faces. Each emotion from each actor was displayed an average of once per 30 trials. None of the match responses were based on matched faces, only matched emotion. For an example, see Figure 6. Thirty percent of trials required a response of match (right arrow). To allow for emotion analysis, more trials were included in the Emotional N-back than the Traditional N-back. The task included a 1-back practice block (12 trials), 2-back practice block (12 trials), and 3 test blocks (90 trials each).

Participants also completed Letter-number sequencing. This is a commonly used working memory measure and is included in large batteries of cognitive tests. This task was included to assess the validity of the working memory tasks but was not used to address any of the research questions for this study.

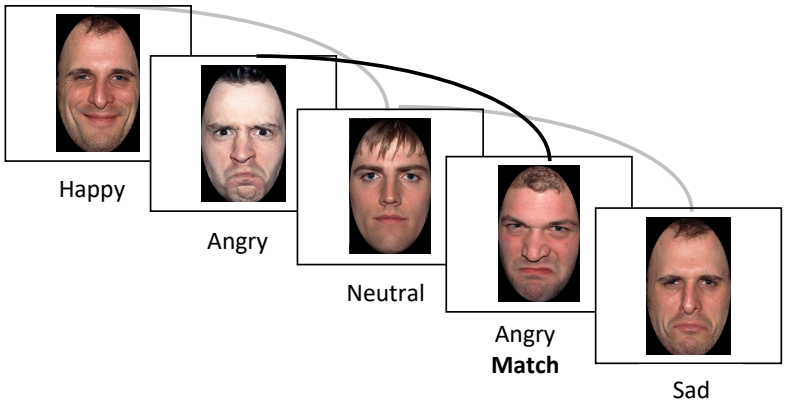


Figure 6. Emotional N-back Example

As the two-back instructions can be difficult to understand, the task first explains a one-back condition (button press indicates if the current stimulus matches the stimulus just seen) and allows participants to practice. Then directions are given for the two-back condition and participants complete a practice session before starting test trials. Each emotion is displayed on the screen for two seconds, then the screen is blank for two and a half seconds before the next emotion is displayed. Timing was modeled after the Levens et al., (2017) emotional N-back. The task includes a one-back practice block (12 trials), a two-back practice block (12 trials) and three test blocks (90 trials each). For each trial, response and response time are recorded. Trials are coded for each emotion, each preceding emotion, and trial type (match-set, break-set, no-set). For an example, see Figure 7.

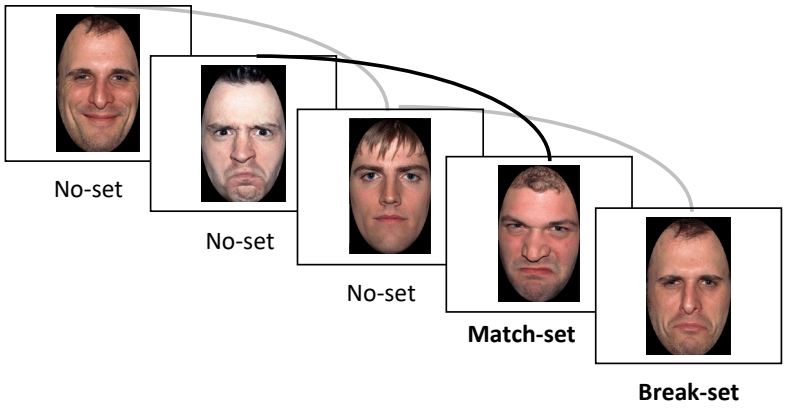


Figure 7. Emotional N-back Trial Types

Traditional N-Back. The traditional N-back task is a computer task developed within E-Prime 2.0. The task displays a single digit on screen, one at a time (i.e., 3…7…8…7…). See Figure 8 for an example. Each digit is on screen for two seconds, with two and a half seconds in between each digit display. The task requires participants to respond to the current stimulus, in the form of single digits, on the screen with a button press indicating if the current digit matches or is different from the digit seen two times previously. Directions are given for the two-back condition and participants complete a practice session before starting testing trials. Timing was modeled after Levens et al., (2017) emotional N-back, as was the emotional N-back used in this study, to ensure that both the traditional and emotional N-back tasks were as similar as possible. This task includes a one-back practice block (12 trials), a two-back practice block (12 trials) and three test blocks (30 trials each). For each trial, response and response time are recorded.

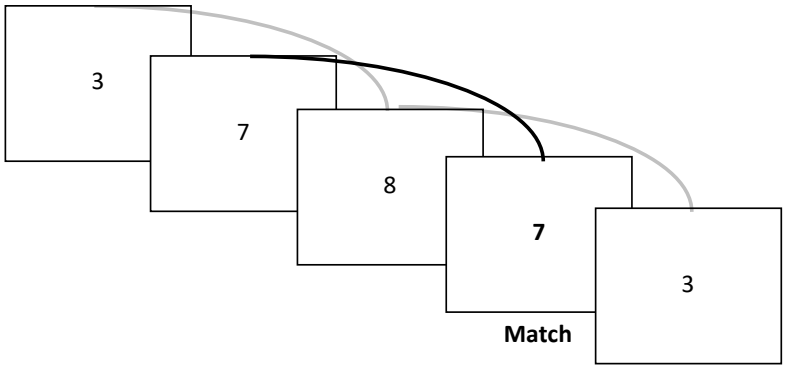


Figure 8. Traditional N-back Example

Procedure

Each participant scheduled a private lab visit with a researcher. Each researcher underwent research protocol training specifically for this study and followed a scripted throughout each participant's session. Once consent was read and any questions answered, each participant completed a Letter-number Sequence. Then the Emotional N-back task was described by the researcher and the participant completed a set of practice trials. Prior to starting the test trials, any questions the participant may have had was addressed. After completing the Emotional N-back, each participant took a five-minute break before beginning the Traditional N-back. Again, the researcher described the task, the participant completed practice trials, and any questions the participant had were addressed. After these two trials, participants completed the demographics and other instruments (i.e. CTQ, TSC, SCL-90, DERS) using an online format in the lab. Then participants completed a paper and pencil Reaction to Research survey. Every participant completed these tasks in the same order. Each participant was debriefed and given a debriefing sheet with contact information. Participants who participated as part of their introductory course credit received three credits for their participation in this study. Participants recruited through other classes or flyers received a $15 gift card to

compensate them for their time. All participants were given a debriefing sheet with a list of local mental health support resources. This lab visit took an hour or less.

Data Analysis

Data analysis was conducted using SPSS software. A preliminary data screening was completed which provided means, standard deviations, and minimum and maximum scores for the continuous variables (Traditional N-back accuracy and RT, Emotional N-back accuracy and RT) to ensure all values were within the expected range. All categorical data were checked for errors.

Demographics

Demographic variables from the self-report demographic questionnaire were used to describe the sample. Descriptive statistics from the demographic variables were used to further inform the analysis.

Anxiety score

A composite score for anxiety was created from the anxiety sub-scales from the TSC and SCL-90. These two anxiety scale scores were significantly correlated ($r(94) = .75$, $p < .001$). Each scale score was converted to a z-score and the two z-scores were averaged for an Anxiety composite score. A median split was done with the composite score to create high and low anxiety groups. There were not any participants who scored at the median anxiety score.

Difficulty in Emotion Regulation Survey

The total score from the DERS was used to determine high and low emotional dysregulation group membership. A median split was done on the total DERS score to create the groups. Two participants scored the median DERS score and were included in the high emotion dysregulation group.

Assumptions Testing

Normality. The continuous variables were tested for normality. This was done by examining frequency distributions, histograms, and statistics of skewness, kurtosis, and the Shapiro-Wilk test of normality. The Traditional N-back accuracy data were negatively skewed. Due to this violation of the assumption of normality, the Traditional N-back accuracy may not be a reliable measure without a transformation. Therefore, the analysis was conducted on both the untransformed and the transformed data using a logarithm method (Howell, 2007; Tabachnick & Fidell, 2007).

Homogeneity of Variance. Leven's test of equality of error variances was used to examine homogeneity of the two groups.

CHAPTER IV

RESULTS

The purpose of this study was to explore working memory performance on tasks differing in emotional content in individuals both with and without a history of childhood maltreatment. In addition, the influences of anxiety and emotion dysregulation on the relationship between working memory performance and childhood maltreatment experience were assessed. Anxiety has been found to interfere with working memory performance (Moran, 2016) and is reported as a common mental health issue for individuals with a history of childhood maltreatment experience (Green et al., 2010). Emotion dysregulation has also been reported to interfere with working memory performance (Gan et al., 2017) and is reported to be higher in individuals with a history of childhood maltreatment (Cicchetti et al., 1991).

The first analysis addressed working memory performance on a traditional, non-emotional working memory task as well as an emotional working memory task based on the group membership in a childhood maltreatment or a comparison group. A 2 (task type) x 2 (maltreatment group) repeated-measures ANOVA examined this relationship and will be referred to as Analysis 1 (A1). The following analyses, described below, separately addressed individuals with high and low anxiety and individuals with high and low emotional dysregulation. The possible interactions of anxiety and emotional dysregulation with CM history and working memory performance on the two tasks were

then explored. This was done by again analyzing working memory performance on both a non-emotional and an emotional working memory task based on the maltreatment group membership along with either anxiety group (low and high) or emotional dysregulation group (low and high), in two separate analyses. The low and high anxiety groups were determined with a median split of the composite score of the TSC anxiety scale and the SCL-90 anxiety scale. The low and high emotion dysregulation groups were determined by a median split of the total DERS score for each participant. Here, two separate 2 (task type) x 2 (maltreatment group) x 2 (anxiety/emotional dysregulation group) repeated-measures mixed method ANOVAs were used and will be referred to as Analysis 2 (A2), which included the anxiety groups and Analysis 3 (A3), which included the emotional dysregulation groups. All analyses were run for both task accuracy and task RT.

Descriptive Statistics

To analyze the three research questions, three categorizes of groups were made. The first group category made was the maltreatment groups consisting of a childhood maltreatment group and a comparison group. The second category was the anxiety groups, made up of high anxiety and low anxiety. The last category was the emotional dysregulation category and included the groups of high emotional dysregulation and low emotional dysregulation. Maltreatment groups were determined by scale scores from the CTQ. Participants with one or more scale scores at the moderate maltreatment severity cut score or higher, as dictated by the measure (Bernstein & Fink, 1998) and described in the Method, comprised the childhood maltreatment group. All other participants were included in the comparison group. The low and high anxiety groups were determined with a median split of the composite score of the TSC anxiety scale and the SCL-90

anxiety scale. The low and high emotion dysregulation groups were determined by a median split of the total DERS score for each participant. The size of each of the groups is reported in Table 3.

Table 3

Group Size

Groups	N
Childhood Maltreatment	44
Comparison	50
High Anxiety	47
Low Anxiety	47
High Emotion Dysregulation	48
Low Emotion Dysregulation	46
Low Anxiety & CM	14
High Anxiety & CM	30
Low Anxiety & Comparison	33
High Anxiety & Comparison	17
Low Emotion Dysregulation & CM	11
High Emotion Dysregulation & CM	33
Low Emotion Dysregulation & Comparison	35
High Emotion Dysregulation & Comparison	15

The traditional and emotional N-back scores were analyzed for the childhood maltreatment and comparison groups to assess the first research question (for group mean scores and RT, see Table 4). For the second research question, the childhood maltreatment and comparison groups were divided by into high and low anxiety sub-groups to be analyzed (for group mean scores and RT, see Table 5). And for the third research questions, the N-back scores for the childhood maltreatment and comparison groups, which had been sub-divided based on high and low emotional dysregulation, were analyzed (for group mean scores and RT, see Table 6).

Table 4

Performance on N-back Task by CM Groups

		Mean	SD
Comparison			
Traditional	Accuracy	0.85	0.18
	RT	851	233
Emotion	Accuracy	0.65	0.17
	RT	1100	159
CM			
Traditional	Accuracy	0.90	0.12
	RT	810	207
Emotion	Accuracy	0.66	0.15
	RT	1083	148

Note: Accuracy is based on a percentage score. RT is measured in milliseconds

Table 5

Performance on N-back Task by CM and Anxiety Groups

		Mean	SD
Comparison			
Low Anxiety			
Traditional	Accuracy	.84	.19
	RT	861	248
Emotion	Accuracy	.65	.16
	RT	1096	160
High Anxiety			
Traditional	Accuracy	.88	.17
	RT	831	208
Emotion	Accuracy	.64	.20
	RT	1107	160
CM			
Low Anxiety			
Traditional	Accuracy	.92	.09
	RT	825	255
Emotion	Accuracy	.67	.15
	RT	1052	98
High Anxiety			
Traditional	Accuracy	.88	.13
	RT	851	247
Emotion	Accuracy	.66	.15
	RT	1097	165

Note: Accuracy is based on a percentage score. RT is measured in milliseconds

Table 6

Performance on N-back Task by CM and Emotional Dysregulation Groups

		Mean	SD
Comparison			
Low Emotion Dysregulation			
Traditional	Accuracy	.83	.19
	RT	881	240
Emotion	Accuracy	.65	.17
	RT	1109	226
High Emotion Dysregulation			
Traditional	Accuracy	.89	.15
	RT	775	202
Emotion	Accuracy	.65	.17
	RT	1077	169
CM			
Low Emotion Dysregulation			
Traditional	Accuracy	.90	.18
	RT	768	145
Emotion	Accuracy	.67	.13
	RT	1069	96
High Emotion Dysregulation			
Traditional	Accuracy	.89	.09
	RT	883	223
Emotion	Accuracy	.66	.16
	RT	1087	161

Note: Accuracy is based on a percentage score. RT is measured in milliseconds

Meeting Assumptions

Normality

The histogram and skewness value for the Traditional N-back accuracy scores indicated a large negative skew. Subsequently, a log transformation was conducted and all analyses for accuracy were run on both the transformed and untransformed data. The conclusions did not differ between the transformed and untransformed data. Therefore, results from the untransformed data are reported.

Homogeneity of Variance

Leven's test was used to assess if the samples had equal variances. The results were not significant for any conditions for accuracy or RT. The traditional N-back accuracy ($F_{(1, 92)} = 2.76$, $p = .100$) and RT ($F_{(1, 90)} = 1.17$, $p = .283$) did not violate the assumption of homogeneity. The emotional N-back also did not violate the assumption for accuracy ($F_{(1, 92)} = 1.62$, $p = .206$) or RT ($F_{(1, 90)} = 1.17$, $p = .283$).

Main Effects

Main Effects of Maltreatment, Anxiety, and Emotion Dysregulation

The aim of this study was to assess the relationship between childhood maltreatment and the performance on two types of working memory tasks as well as investigate the influence of anxiety and emotion dysregulation on the relationship between childhood maltreatment and working memory performance. The focus of the hypotheses was on interactions between the individual difference variables and the emotional content of the working memory task. For simplicity, the main effects of the independent variables will be reported here for all three analyses first. The variables of childhood maltreatment, anxiety, and emotional dysregulation were represented as groups in each analysis. None of these variables were found to have a significant main effect based on overall working memory accuracy or RT in these three analyses (Table 7).

Table 7

Main Effects of Group

	Analysis 1			Analysis 2			Analysis 3		
	F-value	*p*-value	η_p^2	*F*-value	*p*-value	η_p^2	*F*-value	*p*-value	η_p^2
Accuracy									
CM	1.01	.318	.001	.903	.334	.010	.659	.419	.007
Anxiety				.000	.991	.000			
Emotional Dysregulation							.050	.823	.001
RT									
CM	.667	.416	.007	.599	.441	.007	.346	.558	.004
Anxiety				.000	.983	.000			
Emotional Dysregulation							.160	.690	.002

Note: Analysis 1 was a 2 (task type) x 2 (CM group) repeated-measures mixed method ANOVA; Analysis 2 was a 2 (task type) x 2 (CM group) x 2 (Anxiety group) repeated-measures mixed method ANOVA; Analysis 3 was a 2 (task type) x 2 (CM group) x 2 (Emotion dysregulation group) repeated-measures mixed method ANOVA.

Main Effect of Task Type

A significant main effect was found for task type (emotional and traditional) for accuracy ($F_{(1.0, 92)} = 273.13$, $p < .001$, $\eta_p^2 = .748$) and RT ($F_{(1.0, 90)} = 189.24$, $p < .001$, $\eta_p^2 = .678$), based on Analysis 1. For *F* and *p* values from all three analyses, refer to Table 8. As seen in this table, the task main effect was significant in all three analyses. The traditional N-back task was easier ($M = .87$, $SD = .15$) and faster ($M =$. -831.76, $SD =$ 221.13) than the emotional N-back task ($M = .65$, $SD = .16$) ($M = 1091.94$, $SD = 153.19$). Post-hoc t-tests revealed these differences to be statistically significant for both accuracy ($t_{(93)} = 16.47$, $p < .001$) and RT ($t_{(91)} = -13.79$, $p < .001$).

Table 8

Main Effect of Task Type Across All Three Analyses

	Accuracy		RT	
	F-value	*p*-value	*F*-value	*p*-value
Analysis 1	273.13	< .001	189.24	< .001
Analysis 2	257.17	<.001	160.15	< .001
Analysis 3	225.98	< .001	157.94	< .001

Note: Analysis 1 was a 2 (task type) x 2 (CM group) repeated-measures mixed method ANOVA; Analysis 2 was a 2 (task type) x 2 (CM group) x 2 (Anxiety group) repeated-measures mixed method ANOVA; Analysis 3 was a 2 (task type) x 2 (CM group) x 2 (Emotion dysregulation group) repeated-measures mixed method ANOVA.

Does Childhood Maltreatment History Interact with Emotional Content to Predict Working Memory Performance?

The first research question aimed to investigate whether individuals with and without a history of childhood maltreatment displayed differences in working memory performance based on the emotionally manipulated content of the task. Data were analyzed for both accuracy scores and response time (RT). The first research question was assessed by Analysis 1. The means and standard deviations for the control and childhood maltreatment groups are displayed in Table 4.

Analysis 1 found no evidence that the emotional content of the N-back task had a differential effect on performance based on childhood maltreatment. The N-back task x CM group interaction was nonsignificant for accuracy ($F_{(1.0, 92)} = 1.217$, $p = .273$, $\eta_p^2 = .013$) or RT ($F_{(1.0, 90)} = .416$, $p = .520$, $\eta_p^2 = .005$).

Does Childhood Maltreatment History Interact with Anxiety to Predict Working Memory Performance on Tasks Differing in Emotional Content?

The second research question explored the possible interaction of anxiety and CM history related to working memory performance. In this study, anxiety was analyzed as a variable to detect whether anxiety interacts with reported child maltreatment to predict performance on the two N-back tasks. The second research question was analyzed in Analysis 2.

The current study found no evidence of an interaction between maltreatment group, anxiety group, and emotional content of the task to predict working memory performance. No evidence was found for a N-back task x CM group x Anxiety group interaction for accuracy ($F_{(1.0, 90)} = 2.115$, $p = .149$, $\eta_p^2 = .023$) or RT ($F_{(1.0, 88)} = .110$, $p = .741$, $\eta_p^2 = .001$). Also, no evidence was found for a CM group x Anxiety group interaction for accuracy ($F_{(1)} = .359$, $p = .550$, $\eta_p^2 = .004$) or RT ($F_{(1)} = .072$, $p = .789$, $\eta_p^2 = .001$).

Does Childhood Maltreatment History Interact with Emotional Dysregulation to Predict Working Memory Performance on Tasks Differing in Emotional Content?

The third research question addressed the possible influence of emotion dysregulation on working memory performance in individuals both with and without a history of childhood maltreatment. This research question was addressed with Analysis 3.

This study found no evidence of an interaction between maltreatment group, emotion dysregulation group, and task emotional content on working memory performance. The N-back task x CM group x Emotion Dysregulation group interaction

was nonsignificant for accuracy ($F_{(1.0, 90)} = .775$, $p = .387$, $\eta_p^2 = .008$) and RT ($F_{(1.0, 88)} = 1.615$, $p = .207$, $\eta_p^2 = .018$). Also, no evidence was found for a CM group x Emotion Dysregulation group interaction for accuracy ($F_{(1)} = .328$, $p = .558$, $\eta_p^2 = .004$) or RT ($F_{(1)} = 1.726$, $p = .192$, $\eta_p^2 = .019$).

Exploratory Analyses

Following the research of Levens et al., (2017), analyses were conducted to assess working memory performance differences based on trial set. Typically, working memory is measured with total scores and average RTs, but the N-back task involves aspects of updating, disengagement, and pairing (Levens & Gotlib, 2010), that together are required to complete a working memory task. The value of looking at trial sets is the ability to assess components of working memory, instead of only addressing working memory as a composite performance. Three trial set types were assessed. The first were match-sets, which consisted of trials which matched either the number or emotion (based on the task) presented two trials previously. Match-set trials represent correct pairing in the task. The second were break-sets, the trials which directly follow a match-set but are not a match to the trial two previous. Break-set trials indicate disengagement, as participants must disengage from the recent match-set stimuli. The third were no-sets, which were trials that did not match the number or emotion from the trial two times previously, nor followed a match set. No-set trials require the new stimulus to be integrated into working memory. For example, in the stimuli string of 1, 2, 3, 2, 4, no-set trials include 1, the first presentation of 2, and 3. The match set trial is the second presentation of 2. And the break-set trial is 4, as it follows the match set trial. The initial exploratory analyses did not include emotion, as the traditional N-back task did not include emotion stimuli. A 2

(N-back task type) x 3 (trial set) x 2 (CM group) repeated-measures mixed method ANOVA was used to assess group differences across task and trial type. A significant 3-Way interaction was found for task type, trial set, and CM group ($F_{(1.51, 121.01)} = 3.89$, $p = .034$, $\eta_p^2 = .046$) for accuracy (Figure 9). A post-hoc t-test revealed a significant difference between the control and childhood maltreatment groups in accuracy for match set trials only for the traditional task ($t_{(81)} = -2.04$, $p = .045$), with the childhood maltreatment group scoring higher than the comparison group. This interaction was not found for RT. This exploratory analysis also was conducted twice more and included anxiety and emotional dysregulation separately with a 2 (task type) x 3 (trial set) x 2 (CM group) x 2 (anxiety/emotional dysregulation group). Neither anxiety or emotion dysregulation interacted with childhood maltreatment to predict performance at the trial or task level.

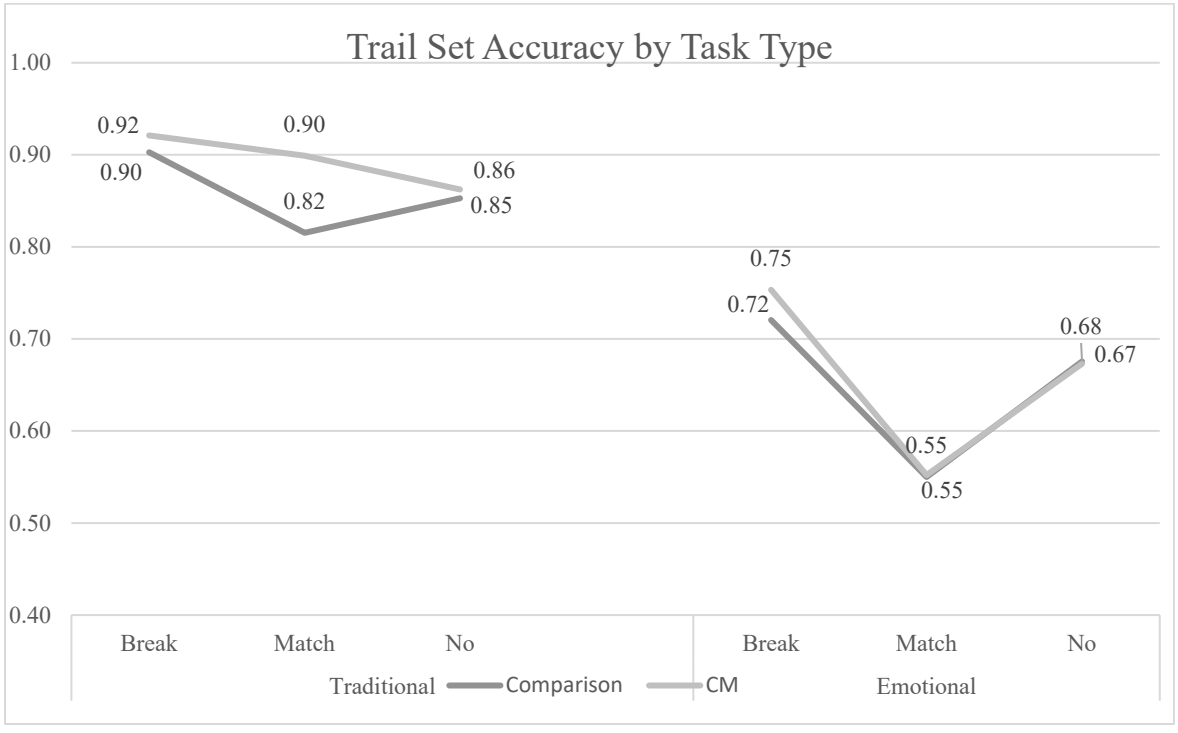


Figure 9. Trial Set Accuracy by Task Type

A second set of exploratory analyses were run to assess the degree to which emotion (angry, fear, happy, neutral, and fear) and trial set (match, break, set) interacted with childhood maltreatment history for the emotional N-back only. These analyses were similar to the analyses conducted by Levens et al., (2017) with their three adversity groups, but for this study the analysis was a 5 (emotion) x 3 (trial set) x 2 (CM group) repeated-measures mixed method ANOVA that was used for both accuracy and RT. There were no significant main effects or interactions involving the childhood maltreatment variable for accuracy or RT, therefore, no further analyses are reported for anxiety or emotional dysregulation. Although childhood maltreatment was the focus of this study, these analyses did yield effects of emotion, trial type, and task, as well as some interaction with anxiety and emotional dysregulation. A table of these results can be found in Appendix F.

CHAPTER V

DISCUSSION

The purpose of this study was to explore the relationship between childhood maltreatment experience and working memory performance on both a traditional and an emotional task while considering the influence of current anxiety and emotional dysregulation. Childhood maltreatment has been linked to a working memory deficit in both children and adults (for a meta-analysis, refer to Masson et al., 2015). Childhood maltreatment is also associated with higher levels of anxiety (Green et al., 2010) and difficulties in emotion regulation (Cicchetti et al., 1991). Both of these mental health factors are associated with poorer working memory performance as well (Kensinger & Corkin, 2003; Moran, 2016) but there has been limited research exploring how they may interact with childhood maltreatment to impact cognitive performance. This study examined working memory in emotional and non-emotional contexts for individuals with and without a history of childhood maltreatment. In addition, the degree to which maltreatment interacted with current anxiety and emotion dysregulation was also assessed. This relationship was explored with a sample of female college students. Childhood maltreatment, anxiety, and emotional dysregulation were measured with the CTQ and working memory was assessed with two versions of the N-back task.

The sample was comprised of female college students. This sample allows for the further development of our understanding of the relationship between childhood

maltreatment and working memory in typically functioning emerging adults. A college student sample allows for the assessment of individuals who are in late adolescence/emerging adulthood. College students are also a useful sample to examine the relationship between childhood maltreatment and working memory as it is likely these individuals just recently left the environment in which they grew up. Poor academic performance has been associated with childhood maltreatment (Duncan, 2000; Strathearn, Gray, O'Callaghan, & Wood, 2001), which may be the consequence of cognitive deficits. In light of the 47% prevalence childhood maltreatment experience in the current sample, understanding the potential deficits in working memory that could interfere with college achievement is of importance. Examining working memory, an ability vital to a classroom setting and adequate learning could help explain the struggle with academic success after childhood maltreatment.

Two other reasons motivated this study of working memory in female college students. First, the research is mixed regarding the relationship between childhood maltreatment and working memory impairments. One meta-analysis revealed working memory to be the most prominent cognitive deficit from childhood maltreatment across the lifespan (Masson et al., 2015). In contrast, other research has not found evidence of working memory differences between adults with and without childhood maltreatment experience (Bremner et al., 1995; Bremner et al., 2004; Tomoda et al., 2011). Second, the mental health factors of anxiety and emotion dysregulation increase with childhood maltreatment experience and are also associated with poorer working memory performance. Past research has examined the impact of these individual differences on working memory performance. No published studies were found that examined whether

anxiety or emotional dysregulation moderate the effect of childhood maltreatment on working memory.

This study also aimed to investigate findings by examining the influence of emotional arousal on individual differences in working memory performance. One approach to this question was to explore the degree to which anxiety and emotion dysregulation interacted with maltreatment to impact performance. The second approach involved comparing an emotional working memory task with a traditional working memory task. Previous research has indicated that arousing stimuli, such as emotional faces, can alter working memory performance in typical participants (Kensinger & Corkin, 2003). But research utilizing arousing stimuli in working memory tasks is limited for maltreatment samples and these studies do not include a traditional working memory task for comparison. Research aimed at exploring working memory deficits after childhood maltreatment should be studied under conditions of arousal. Research has linked history of childhood maltreatment experience with difficulties regulating emotion, anxiety, memory deficits, and academic struggles. To accomplish a more thorough investigation into childhood maltreatment and working memory, the current study included two types of working memory tasks: a traditional N-back with digit stimuli and an emotional N-back with emotional face stimuli. This design is unique among previous childhood maltreatment studies. While other maltreatment research has utilized either a traditional or an emotional working memory task, they have yet to compare performance on both in the same study. Using both an emotional and a traditional N-back task in this study made it possible to examine the differential effect of emotional content on working

memory performance in maltreatment, as well as in groups that differed in anxiety and emotion dysregulation.

Analysis of Research Questions

The first research question aimed to identify if participants who differ in maltreatment history would perform differently on two working memory tasks that differed in emotional content. No evidence of a performance difference was found. Potential explanations involve the nature of the sample and the literature that motivated the study.

In this study, childhood maltreatment was measured with the widely used CTQ. The benefits of this self-report measure include a sub-scale for three types of child abuse (physical, emotional, and sexual) and two types of neglect (physical and emotional). Some research is limited to one type of abuse, such as sexual abuse, while many other studies avoid aspects of neglect or emotional maltreatment. In addition to including five types of maltreatment, each type is assessed by five questions, allowing for a variation in scores from mild to extreme rather than a yes/no binary result. The current study did not address each type of maltreatment, but the sub-scales allowed for a more detailed description of the childhood maltreatment sample. The CTQ also includes sub-scale cutoffs for moderate to extreme maltreatment scores, allowing for severity of maltreatment to be observed. The maltreatment types with the highest rates of reporting for this sample were emotional abuse (33%), physical neglect (26%), and sexual abuse (20%; see Table 2 on page 45 for all maltreatment types). Some studies limit the types of maltreatment being addressed; for example, they may only include childhood sexual abuse cases or only look at aspects of abuse and exclude cases of neglect. Often cases of

emotional abuse or emotional neglect are not considered. It is possible that different types of maltreatment experience produce different effects on cognitive ability.

A sub-set of studies in the literature assessing childhood maltreatment and working memory also failed to find differences between individuals with maltreatment experience and controls (Bremner et al., 1995; Bremner et al., 2004; Tomoda et al., 2011). In previous research, Bremner et al., (2004) looked specifically at adult survivors of childhood physical and sexual abuse and Bremner et al., (1995) looked only at adult survivors of childhood sexual abuse. In contrast, some studies in the meta-analysis that demonstrated childhood maltreatment differences in working memory only included individuals with sexual abuse (Raskin, 1997) or parental verbal abuse (Tomoda et al., 2011) in their samples. Research with only childhood sexual abuse samples has found differences in working memory (Raskin, 1997) and failed to find such differences (Bremner et al., 2004). It should be considered that the type of maltreatment addressed in the samples examined by these studies could influence the findings on working memory performance.

Another possible reason for the null findings in this study could be that the relationship between childhood maltreatment and adult working memory performance is misrepresented in the literature. In the Masson et al. (2015) meta-analysis, a total of seven studies assessing working memory in adults both with and without a history of childhood maltreatment were included in the analysis which found group differences. Other studies with null results between maltreatment and working memory may appear scarce due to publication bias. The studies that do report null findings between maltreatment and working memory conducted large batteries of cognitive testing and

were published based on other findings (Bremner et al., 1995; Bremner et al., 2004; Tomoda et al., 2011). It is possible that more studies looking specifically at working memory and childhood maltreatment also failed to find a relationship and were never published. The Masson et al. (2015) meta-analysis might have overestimated the working memory deficit associated with childhood maltreatment experience because multiple studies included in the analysis assessed clinical samples. It could be assumed that mental health symptoms were more severe in these clinical samples than what would be observed in a college sample. It has been observed that different types of maltreatment can be linked to different mental health outcomes. This was displayed by Faravelli et al. (2014) who reported different mental health symptoms based on the early life experiences of loss, neglect, sexual abuse, and physical abuse. Many maltreatment studies aim to investigate clinical populations of Borderline Personality Disorder, Major Depressive Disorder, or Posttraumatic Stress Disorder, when mental health symptoms are more extreme. Mental health factors have been found to affect working memory performance (e.g. Moran, 2016). In fact, for this study, the possible interactions of two mental health factors, anxiety and emotion dysregulation, were considered due to previous research reporting an influence each had on working memory performance. If mental health symptoms vary based on the type of maltreatment experienced, the type of maltreatment sequelae may have differential effects on cognitive abilities. Assessing different types of maltreatment, or studies including different rates for each maltreatment type, may lead to different findings for working memory. It is possible that the null findings for this study occurred due to differences in working memory performance that could not be detected when all types of maltreatment type were collapsed into one group. Also, current mental

health status should be considered when assessing working memory performance. Therefore, anxiety and emotion dysregulation were explored in the other two research questions.

The second and third research questions assessed if current anxiety or emotional dysregulation interacted with maltreatment experience to differentially affect working memory performance on the traditional and emotional tasks. There was no evidence for a three-way interaction with either anxiety or emotion dysregulation. Again, no evidence was found for this interaction. For this study, the childhood maltreatment group was comprised of individuals who indicated moderate or higher levels of maltreatment on one or more scales of the CTQ. The groups for high and low anxiety and high and low emotional dysregulation were created by a median split of the total scores for both anxiety and emotion dysregulation. It is possible that the formation of the groups for maltreatment, anxiety, and emotional dysregulation were linked to the null findings between these factors and working memory performance. It may be more beneficial to create groups from the highest and lowest quartiles of each spectrum. The cognitive differences this study aimed to address may be subtle in a college population due to age and resilience to maltreatment experience. Therefore, looking at the more extreme cases of childhood maltreatment and current mental health may allow for this possible effect to be observed. Studies looking at childhood maltreatment experience in clinical samples (such as BPD, MDD, and PTSD) found working memory differences in individuals suffering with severe mental health symptoms after maltreatment experience (Bücker et al., 2013; Gould et al., 2012; Pederson et al., 2004). Also, Levens, et al., (2017) found working memory differences after taking only the highest and lowest adversity scores to

comprise each of their groups. This was not possible in the current study due to sample size. If a larger sample could have been obtained, it might have been beneficial to compare individuals in the highest quartile or third of the distribution of CTQ scores with a comparison group composed of individuals in the lowest CTQ quartile or third of CTQ scores. With a much larger sample this could also be done with anxiety and emotional dysregulation, rather than a median split. While it cannot be determined from this study, it is possible working memory differences exist between individuals who lie on the more extreme ends of the spectrums of childhood maltreatment, anxiety, and emotional dysregulation. Unfortunately, this study lacked the sample size to properly analyze this.

Exploratory Findings

Following the analytic approach used by Levens and Gotlib (2010) and Levens et al., (2017), analyses were conducted to evaluate performance differences across groups for both the trial type and trial emotions. By further investigating N-back performance based on trial types and trial emotion, greater insight can be gained as to whether maltreatment group differences were seen for specific working memory components or emotional trials. Levens and Gotlib (2010) describe trial sets as representing the components of working memory that are needed to properly complete the N-back task. No-set trials represent the integration of new information as each new trial is presented; break-set trials signify the need to "break" or disengage from the match-set that occurred in the previous trial; and match-sets require the participant to accurately link the current trial's emotion to the emotion of the trial which was presented two times previously, essentially displaying precise working memory. To further investigate these factors N-back type (traditional and emotional) and trial (match, break, and no) set were first

analyzed with maltreatment groups, maltreatment and anxiety groups, and maltreatment and emotion dysregulation groups in the first set of exploratory analyses. Then, trial set and trial emotion were analyzed with the three individual difference variables in the second set of exploratory analyses on the emotional N-back only.

The first exploratory analysis revealed a relationship between childhood maltreatment and trial type, specifically with match-set trials, in the traditional N-back task accuracy, not RT. Specifically, the maltreatment group displayed a higher accuracy for match-set trials in the traditional N-back task. The accuracy scores for break-set and no-set trials did not differ from the comparison group. This effect was not found for the emotional N-back task. If future research extended this investigation into the trial types, the relationship between childhood maltreatment and working memory performance could be better understood. The preliminary evidence from this study suggests that childhood maltreatment experience may influence specific components of working memory in different ways, as individuals with a maltreatment history performed better on match-set trials but did not perform differently from controls on the break-set or no-set trials. This indicates better performance on linking matching trials than on trials of disengagement or integration. Levens et al., (2017) also found superior performance in the participants with distant adversity experience (likely to include cases of childhood maltreatment) in the form of faster reaction times on break-set trials, reflecting faster disengagement of working memory. Similarly, the current study observed higher accuracy rates for individuals with maltreatment experience on match-set trials, displaying the ability to correctly link the current emotion with the emotion presented two time previously. Interestingly, this maltreatment group difference based on trial type

was found on traditional N-back performance, a condition which was not included in the Levens et al., (2017) study. Also, the current study did not exclude individuals scoring within two standard deviations of the mean childhood trauma score on the CTQ, as was done with the adversity scale used by Levens et al., (2017). The more extreme groups on the adversity dimension, such as the sample included in the Levens et al., (2017) study, may have been more sensitive to working memory deficits in emotional conditions than what was found in the current study. It is important to note that the enhanced working memory performance in the adversity and childhood maltreatment groups in the study Levens et al., (2017) study and the current study, respectfully, are surprising and unexpected findings. Further research assessing trial types in a traditional N-back task are needed to examine if this finding can be replicated or if it represents random error.

The second set of exploratory analyses did not reveal childhood maltreatment group differences, and therefore was not a focus of the description in the Results section. However, it is of interest that anxiety and emotional dysregulation group differences were found in these analyses (see Appendix F). Anxiety group differences were found for trial type. The high anxiety group preformed significantly better than the low anxiety group in accuracy on match-set trials, collapsed over the traditional and emotional tasks. A three-way interaction of anxiety group x trial type x trial emotion was also revealed. The nature of this interaction was slower RTs in the high anxiety group, but only for break-set trials for fear and happy faces. This could be an indication that individuals who experience high anxiety have difficulty disengaging from previous stimuli when fearful or emotional faces are present. For emotion dysregulation groups, a three-way interaction of emotion dysregulation group x trial type x trial emotion was also found. This interaction was

reflected in the high emotion dysregulation group performing faster on match-set trials, but only for angry and fearful faces. This represents another superiority in working memory ability in a group with presumed difficulties in regulating emotional arousal that is difficult to explain. While these results are interesting, they were only revealed in exploratory analyses. More research and replication would be needed to determine if these finding are indicative of actual differences among individuals suffering from anxiety and emotion dysregulation. The significant results among the exploratory analyses in the current study are indications that aspects of trial set and trial emotion should be examined further in continued research.

The purpose of this study was to investigate the relationship between childhood maltreatment and working memory performance, as well as the possible interaction of anxiety and emotion dysregulation. Exploratory analyses revealed current symptomology, not maltreatment experience, to relate to working memory performance when trial type and trial emotion were analyzed. This could be an indication that current mental health plays a larger role in emotion working memory performance than childhood maltreatment experience. At the very least, these findings do emphasize the importance of measuring and considering the influence current mental health factors when investigating working memory and other domains of executive function.

Limitations of the Current Study

The sample used in the current study included three major research limitations. First, only females were assessed in an effort to avoid confounding variables. Gender differences have been reported on some working memory tasks (e.g. Speck et al., 2000) and child maltreatment self-reports (e.g. Bernstein et al., 1997). Even though it is

common within childhood maltreatment research to study all-female samples, it does present some limitations. Females are more likely to self-report experiencing sexual abuse and emotional abuse than males (Bernstein et al., 1997). Due to the nature of self-report measures, it cannot be determined if these higher rates of reporting are due to a vulnerability to specific types of abuse (which might be considered for cases of sexual abuse), under-reporting on the part of male participants (which could be considered for cases of emotional abuse), or over-reporting on the part of female participants. It is possible that childhood maltreatment group membership in this study is skewed due to the decision to only recruit female participants. Second, the sample in this study also was limited to individuals who were between 18 and 30 years of age and currently attending college. Generalizations cannot be made to older adults or the general young adult population.

Third, all groups were formed based on scores from self-report measures from an unselected volunteer sample. When crossing maltreatment status with high and low anxiety or emotion dysregulation the natural correlation between maltreatment and these two individual difference variables emerged. For example, the group representing individuals with childhood maltreatment and high anxiety was larger than the group representing individuals without a history of maltreatment and high anxiety. Based on previous research, higher rates of anxiety and emotion dysregulation were expected for the childhood maltreatment group. However, the disproportionate representation and small samples within some groups limited the statistical analyses.

Another area of limitations involves the task that was used in the study. The traditional N-back that was used only included a 2-back condition. Initially, this was done

to keep both the traditional and the emotional N-back tasks as similar as possible and both only included a 2-back condition. However, this led to a ceiling effect and negatively skewed data for traditional N-back scores. Including a 3-back condition would have increased the difficulty level of the task. With the addition of a 3-back condition to the traditional N-back a ceiling effect likely could be avoided and a greater variation in traditional N-back accuracy data would likely be observed. However, it should be considered that adding a 3-back condition to the emotional N-back may cause the task to be too difficult. Also, the current traditional N-back task included one-third the number of trials as the emotional N-back. The emotional N-back was longer to allow for each emotion to include enough trials to have adequate power for analysis. However, the uneven number of trials across the tasks may have created an unintentional methodological limitation.

The addition of a 0-back condition to the emotional N-back could also improve this study. A 0-back condition would require participants to have one response (i.e. pressing the right arrow key) to a target emotion (i.e. angry), while all emotions not matching the target emotions receive a difference response (pressing the left arrow for fear, happy, neutral, and sad faces). Other researchers have included a 0-back condition to measure the accuracy and response time of the perceptual process needed to evaluate the emotional stimuli. By measuring these baseline processes, they can be controlled for in a study (Levens & Gotlib, 2010). As this study did not include a 0-back condition, it was not possible to control for any differences in perceptual processing that may have existed between the childhood maltreatment group and the comparison group. As determined by the Masson et al. (2015) meta-analysis, speed of processing and attention

were cognitive domains significantly affected by childhood maltreatment (along with working memory). Since these cognitive processes have been found to suffer after childhood maltreatment experience it would be beneficial to further investigate both attention and processing speed as they both could influence working memory performance. By adding a 0-back condition, accuracy and RT could provide baseline measurements for attention and processing speed. A lack of attention could be indicated by substantial low accuracy or long RTs as these may be signs of off task behavior. Speed of processing would be reflected by RT in the 0-back condition, which requires less mental effort than a 2-back condition. Attention and speed of processing could influence N-back measurements and a 0-back task could account for these two cognitive processes. By including a 0-back condition in future research, differences in processing could be controlled for when analyzing working memory performance in a 2-back or 3-back N-back that includes emotional content.

The two N-back tasks utilized in the current research study aimed to identify differences between traditional working memory and emotional working memory. This task was chosen for its dynamic working memory measurement capabilities and its adaptation to an emotional working memory task in other studies. However, a ceiling effect was observed for the traditional N-back task. It also may have been beneficial to account for attention and speed of processing. Both of these cognitive functions are known to suffer in individuals with a history of childhood maltreatment are both likely to influence N-back performance.

Future Directions

In future research, it would helpful to consider different manipulations and different working memory tasks to evaluate both traditional and emotional working memory ability. The current study manipulated a N-back task by replacing traditional, neutral stimuli (digits) with emotional faces. In this instance, the emotion of each face was task-relevant as the emotion of each trial was identified as matching or not matching the emotion of the trial which came two times previously. The N-back task could also be altered to contain neutral digit stimuli and distraction stimuli, in the form of emotional faces. The emotional stimuli could flank each side of the trial's presented digit. This would change the emotional stimuli to be task-irrelevant, as it is used as a distractor and the emotion is relevant for the task to be completed properly. It is possible that this would make the task easier to complete, as the prime objective requires identifying a digit rather than an emotion. Also, this manipulation would still allow for trial sets to be examined, which may prove useful to understanding the relationship between childhood maltreatment experience and working memory.

Another consideration is to use a different working memory task. One option is the Emotional Working Memory Task, that was used by Krause-Utz and colleagues (2012) in a sample of Borderline Personality disorder patients with and without a history of childhood maltreatment. This computer task presents three letters to a participant, followed by a short interval that can contain a fixation point or a distraction photograph. Then the screen presents three letters and the participants is asked if any of the three letters were presented in the first slide. The participant responds with a button press indicated "Yes" or "No." This task does not allow for aspects of disengaging, linking, or

encoding to be examined. Yet, the benefits of this task are similar to the N-back, as it is easy to manipulate a traditional task (with a fixation point) into an emotion task (when an emotional distractor replaces the fixation point). Other maltreatment research has not addressed differences in emotional working memory compared to traditional working memory among individuals with and without a history of maltreatment but including an emotional manipulation could help us better understand the affect maltreatment experience has on this executive function. This computer task would also allow for both accuracy and RT to be measured, which would allow for a common measure of accuracy to be included with a more sensitive measure of RT.

The goal of this study was to more thoroughly investigate differences in working memory performance among individuals with and without a history of childhood maltreatment. The current mental health factors of anxiety and emotion dysregulation were also measured and analyzed, as both are found to influence working memory as well as be common among individuals with a maltreatment history. This study failed to provide clarification on conflicting evidence on the relationship between childhood maltreatment and working memory differences. However, this research did yield some helpful insights regarding the ways future research could be approached based on how groups are comprised, possible alterations to working memory tasks, and the value of continued analysis of mental health and trial types within N-back tasks. The high prevalence of childhood maltreatment experience and the impact of childhood maltreatment on college academic performance indicates a need for continued research and a greater understanding of the impact of maltreatment on working memory.

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APPENDIX A

INSTITUTIONAL REVIEW BOARD APPROVAL LETTER

UNIVERSITY OF
NORTHERN COLORADO

Institutional Review Board

DATE: February 18, 2019

TO: Mackenzie Ann Peake Pohja, MA
FROM: University of Northern Colorado (UNCO) IRB

PROJECT TITLE: [1326030-6] The Impact of Stressful Life Events on Cognition and Emotion
SUBMISSION TYPE: Amendment/Modification

ACTION: MODIFICATION APPROVED
APPROVAL DATE: February 18, 2019
EXPIRATION DATE: November 12, 2019
REVIEW TYPE: Expedited Review

Thank you for your submission of Amendment/Modification materials for this project. The University of Northern Colorado (UNCO) IRB has APPROVED your submission. All research must be conducted in accordance with this approved submission.
This submission has received Expedited Review based on applicable federal regulations.

Please remember that informed consent is a process beginning with a description of the project and insurance of participant understanding. Informed consent must continue throughout the project via a dialogue between the researcher and research participant. Federal regulations require that each participant receives a copy of the consent document.

Please note that any revision to previously approved materials must be approved by this committee prior to initiation. Please use the appropriate revision forms for this procedure.

All UNANTICIPATED PROBLEMS involving risks to subjects or others and SERIOUS and UNEXPECTED
adverse events must be reported promptly to this office.

All NON-COMPLIANCE issues or COMPLAINTS regarding this project must be reported promptly to this
office.

Based on the risks, this project requires continuing review by this committee on an annual basis. Please use the appropriate forms for this procedure. Your documentation for continuing review must be received with sufficient time for review and continued approval before the expiration date of November 12, 2019.

Please note that all research records must be retained for a minimum of three years after the completion of the project.

If you have any questions, please contact Nicole Morse at 970-351-1910 or nicole.morse@unco.edu. Please include your project title and reference number in all correspondence with this committee.

APPENDIX B

CONSENT FORMS

Consent Form for Course Credit Participants

INFORMED CONSENT FOR PARTICIPATION IN RESEARCH

Project Title: The Impact of Stressful Life Events on Cognition and Emotion
Researchers: **Researchers**: Eric Peterson, Marilyn Welsh, Mackenzie Ann Peake Pohja, Kathryn LaFary, Natalie Johnson, Stephanie Kriesher, Susannah Moore, Drew Weller, Kristen Stoddard, Hannah Baker, Chloe Johnson, Kenzie Rose Brazalle, Samantha Caputo, Anne Boris, Josiah Flores, Breana Hopper, Josh McKeon, and Claire Witt.
Contact Information: 351-1057, 351-2236; eric.peterson@unco.edu or marilyn.welsh@unco.edu
Project Description. We are exploring the influence of stressful life experiences on working memory. Working memory is the mental ability to hold and manipulate information "online" as you may do while doing a simple math problem in your head. The central goal of our research is to understand the degree to which different stressful life experiences may or may not cause difficulty for students in college.
Procedure for Participation. This study will involve a single visit of approximately 1.5 hours in our laboratory, including a break. If you choose to participate you will complete the following cognitive tasks: (1) Letter-Number Sequencing test of working memory, (2) two N-Back tasks of working memory, (3) surveys addressing emotional regulation, mental health, and stressful childhood experiences. Please be aware that your involvement in each aspect of our study is completely voluntary. You may choose to withdraw from the study at anytime without penalty. Further, you may choose not to answer any particular questions or not to complete any single part of the study.
Confidentiality. In order to maintain strict confidentiality, all of your data will be recorded and stored confidentialy. In other words, your name or any other self-identifying information will not be included on any of the data. Rather, your data will be stored using a simple anonymous numbering system. Data and consent forms will never be stored together, and both will always remain locked in a secure location. Other than the researchers, no one will have access to your individual data. No information about you will be shared with professors, students, or anyone else. We will maintain the highest possible standards for protection of privacy. However, please be aware that if at any time during your visit, if you verbally disclose information related to a possible crime or any thoughts of harming yourself or others we are required to report that information to the appropriate authorities.
Risks and Benefits. Some people find cognitive tasks and answering questions about themselves somewhat stressful. Therefore, if you choose to end your participation at any time or not answer particular questions on the survey, you may do so. Your wellness is of the highest priority and we encourage participants to express any distress they experience as a result of participating in our study. Your participation in this study will not result in any direct benefit to you as an individual. However, your participation will certainly make a contribution to a research question that we believe is important. For your visit today, you will be granted 3 research credits in the Sona System. Further, your participation will certainly make a contribution to a research question that we believe is important.

Participation is voluntary. You may decide not to participate in this study and if you begin participation you may still decide to stop and withdraw at any time. Your decision will be respected and will not result in loss of benefits to which you are otherwise entitled. Having read the above, let your researcher know if you have any questions. This form is for you to keep and retain for future reference. If you have any concerns about your selection or treatment as a research participant, please contact Nicole Morse, IRB Administrator, in the Office of Sponsored Programs, Kepner Hall, University of Northern Colorado, Greeley, CO 80639, (970) 351-1910.

Consent Form for Gift Card Participants

UNIVERSITY OF NORTHERN COLORADO

INFORMED CONSENT FOR PARTICIPATION IN RESEARCH

Project Title: The Impact of Stressful Life Events on Cognition and Emotion
Researchers: **Researchers**: Eric Peterson, Marilyn Welsh, Mackenzie Ann Peake Pohja, Kathryn LaFary, Natalie Johnson, Stephanie Kriesher, Susannah Moore, Drew Weller, Kristen Stoddard, Hannah Baker, Chloe Johnson, Kenzie Rose Brazalle, Samantha Caputo, Anne Boris, Josiah Flores, Breana Hopper, Josh McKeon, and Claire Witt.
Contact Information: 351-1057, 351-2236; eric.peterson@unco.edu or marilyn.welsh@unco.edu

Project Description. We are exploring the influence of stressful life experiences on working memory. Working memory is the mental ability to hold and manipulate information "online" as you may do while doing a simple math problem in your head. The central goal of our research is to understand the degree to which different stressful life experiences may or may not cause difficulty for students in college.
Procedure for Participation. This study will involve a single visit of approximately 1.5 hours in our laboratory, including a break. If you choose to participate you will complete the following cognitive tasks: (1) Letter-Number Sequencing test of working memory, (2) two N-Back tasks of working memory, (3) surveys addressing emotional regulation, mental health, and stressful childhood experiences. Please be aware that your involvement in each aspect of our study is completely voluntary. You may choose to withdraw from the study at anytime without penalty. Further, you may choose not to answer any particular questions or not to complete any single part of the study.
Confidentiality. In order to maintain strict confidentiality, all of your data will be recorded and stored confidentialy. In other words, your name or any other self-identifying information will not be included on any of the data. Rather, your data will be stored using a simple anonymous numbering system. Data and consent forms will never be stored together, and both will always remain locked in a secure location. Other than the researchers, no one will have access to your individual data. No information about you will be shared with professors, students, or anyone else. We will maintain the highest possible standards for protection of privacy. However, please be aware that if at any time during your visit, if you verbally disclose information related to a possible crime or any thoughts of harming yourself or others we are required to report that information to the appropriate authorities.
Risks and Benefits. Some people find cognitive tasks and answering questions about themselves somewhat stressful. Therefore, if you choose to end your participation at any time or not answer particular questions on the survey, you may do so. Your wellness is of the highest priority and we encourage participants to express any distress they experience as a result of participating in our study. Your participation in this study will not result in any direct benefit to you as an individual. However, your participation will certainly make a contribution to a research question that we believe is important. For your visit today, you will be given a $15 gift card. Further, your participation will certainly make a contribution to a research question that we believe is important.

Participation is voluntary. You may decide not to participate in this study and if you begin participation you may still decide to stop and withdraw at any time. Your decision will be respected and will not result in loss of benefits to which you are otherwise entitled. Having read the above, let your researcher know if you have any questions. This form is for you to keep and retain for future reference. If you have any concerns about your selection or treatment as a research participant, please contact Nicole Morse, IRB Administrator, in the Office of Sponsored Programs, Kepner Hall, University of Northern Colorado, Greeley, CO 80639, (970) 351-1910.

APPENDIX C

DEBRIEFING FORM

UNIVERSITY OF
NORTHERN COLORADO

The Impact of Stressful Life Events on Cognition and Emotion

First, thank you for your willingness to participate in our study. The success of our research depends so much on volunteers like you. We can be contacted at the following email addresses: Dr. Eric Peterson: eric.peterson@unco.edu; Dr. Marilyn Welsh: marilyn.welsh@unco.edu; Mackenzie Ann Peake Pohja: peak7710@bears.unco.edu.

What is Our Research All About? We are studying college students with a history of child maltreatment (and other related stressful life events). Unfortunately, many individuals have endured such harmful early environments. Others may experience similarly stressful life events in adulthood. While a life history of maltreatment is associated with increased risk for difficulties in adulthood (e.g., depression or anxiety), we know that many people show resilience. That is, many individuals do surprisingly well despite their history. Indeed, anyone with a maltreatment history who achieves a beginning in college has already demonstrated real strength in the face of adversity.

Some studies have reported that individuals with a history of childhood maltreatment struggle with working memory, while others have not found differences. Working memory performance is linked to anxiety and emotion regulation, but this has not been assessed in individuals with maltreatment experience. This study is designed to detect if anxiety and/or emotion regulation are linked to possible differences in working memory performance among individuals with a without a history of childhood maltreatment.

The following are resources available to you on campus should you want to use them:

UNC Counseling Center ***(Free to students)***

Cassidy Hall
Second Floor

Phone: **970-351-2496**
http://www.unco.edu/counseling-center/
UNC Psychological Services Clinic (Reduced rates)
McKee Hall
Room 247
Phone: **970-351-1645**
psc.unc@unco.edu
http://www.unco.edu/cebs/psychological-services-clinic/
Emergency and After-Hours Crisis Resources

If you or a friend need help after the regular Monday-Friday office hours, please contact the following resources:

Medical or Police Emergencies: 911

UNC Police: 970-351-2245

North Range Behavioral Health Emergency Line: 970-347-2120

Assault Survivor Advocacy Program (ASAP) Hotline: 970-351-4040

Suicide Prevention Lifeline: 1-800-273-8255

Colorado Domestic Violence Hotline: 1-800-778-7091

National Domestic Violence Hotline: 1-800-799-SAFE

Rape, Abuse and Incest National Network (RAINN): 1-800-656-HOPE

APPENDIX D

REACTION TO RESEARCH QUESTIONNAIRE

		Strongly disagree (No)	Disagree	Neutral (Maybe)	Agree	Strongly agree (Yes)
1	I gained something positive from participating.					
2	The research raised emotional issues for me that I had not expected.					
3	I gained insight about my experiences through research participation.					
4	The research made me think about things I didn't want to think about.					
5	I found the questions too personal.					
6	I found participating in this study personally meaningful.					
7	I believe this study's results will be useful to others.					
8	I experienced intense emotions during the research session and/or parts of the study.					
9	I think this research is for a good cause.					
10	I found participating beneficial to me.					
11	I like the idea that I contributed to science.					
12	I was emotional during the research session.					

APPENDIX E

PROCEDURE FOR INSURING PARTICIPANT PSYCHOLOGICAL WELL BEING

Procedure for Insuring Participant Psychological Well Being

At the end of each session, participants will complete the Revised Reactions to Research Participation Questionnaire. Responses on this questionnaire will be especially important for those individuals endorsing a trauma history. The sequence of procedures is as follows:

1. After each visit, the participant will complete the Reactions to Research Questionnaire Revised (Newman, Willard, Sinclair, and Kaloupek, 2001).

2. The researcher will review participants' responses. Each researcher will be trained on this study's protocol and participant well-being procedures to ensure the researcher is capable of intervention if necessary. While intervention (see chart below) has to date not been needed for this study as participants have not demonstrated a concerning level of distress, all researchers will be trained and prepared if the need arises during the course of this study. The following items relate specifically to mental health concerns and will be examined:
    a. "The research raised emotional issues for me that I had not expected"
    b. "The research made me think about things I didn't want to think about"
    c. "I found the questions too personal"
    d. "I experienced intense emotions during the research session and/or parts of the study"
    e. "I was emotional during the research session"

3. If a participant **has not endorsed** these items (meaning they rated items above as Neutral, Disagree, or Strongly Disagree), **we do a "verbal check-in" ("I know you were asked some very personal questions. How are you doing?"). If they indicate no distress, the researcher gives them the debriefing form and lets the participant know that the study session is over. If they do indicate distress, the procedures in #4 will be followed.**

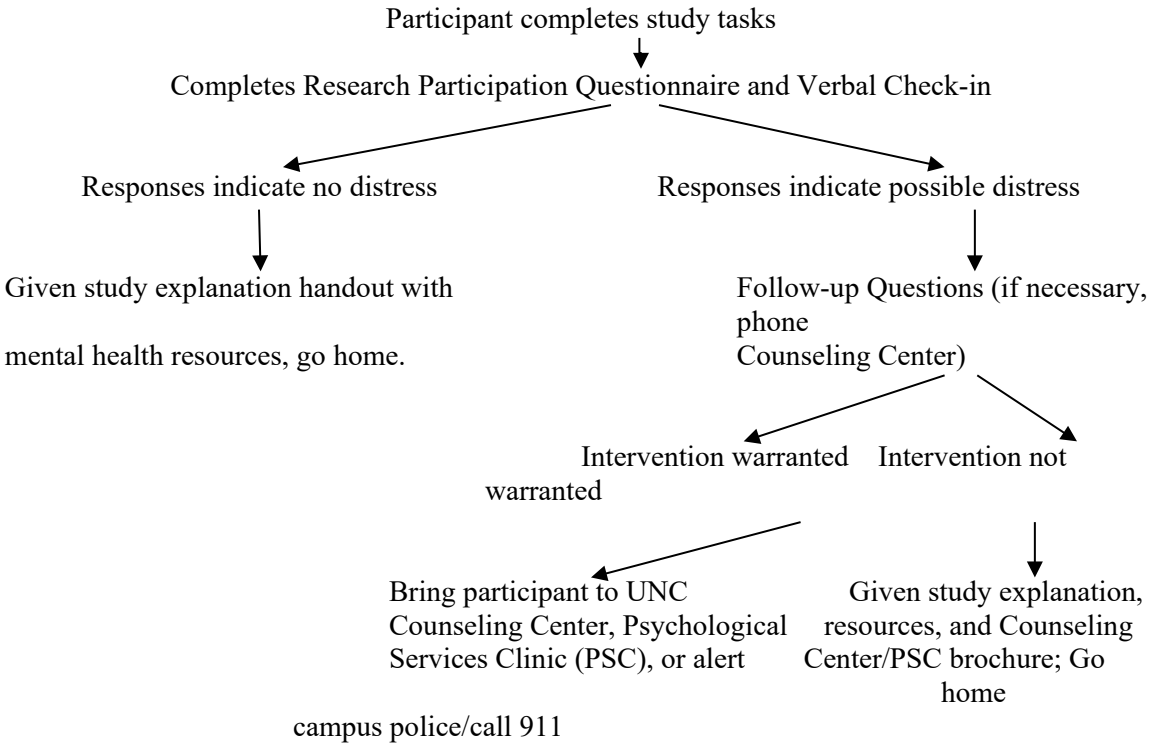
4. If a participant has endorsed these items (meaning those who rated Agree or Strong Agree on **any** items listed above), the participant will be asked, "Are you feeling upset right now?" and "Would it help to talk with someone?" **If the participant expresses the need to talk with someone immediately, the UNC Counseling Center will be contacted to help determine a course of action. Based on the advice of a licensed professional at the Counseling Center:**

    a. **If immediate intervention is not warranted**, participant will be provided with a brochure to the Counseling Center **and/or** Psychological Services Clinic and will then be free to leave.
    b. If immediate intervention is warranted, the researcher will **offer to** accompany the participant to either UNC's Counseling Center (where a doctoral level or licensed psychologist would be available to meet with the student) or Psychological Services Clinic (where a doctoral level counseling student would be available to meet with the student) and **support the participant's immediate access to** mental health services. **If the student is considered a risk to themselves or others (e.g. threat of suicide), the researcher will call 911 (on campus this number reaches the UNC emergency police response team).**
    c. In the unlikely case that immediate measures for services have been taken, researchers will contact the Dean of Students, the faculty advisors (Peterson and/or Welsh), and the IRB as soon as it is safe to do so.

d. NOTE: We have tested more than 500 UNC participants on these sensitive measures and a participant has never indicated a need for immediate mental health assistance.

5. Before leaving, each participant will be given a typed handout that describes the purpose of our study and includes a list of mental health resources (see attached).

Decision Tree



APPENDIX F

EXPLORATORY ANALYSIS

Exploratory Analyses: Set 1

Table 9

N-back Type, Trial Set, and Maltreatment Group

	df	Error	*F*-value	*p*-value
Main Effect				
Task				
Accuracy	1.00	81.00	227.96	< .001
RT	1.00	80.00	176.17	< .001
Set				
Accuracy	1.47	119.30	42.09	< .001
RT	1.47	117.94	67.02	< .001
Interaction				
Task x Set				
Accuracy	1.51	121.91	33.89	< .001
Task x Set x CM				
Accuracy	1.51	121.91	3.89	0.034

Table 10

N-back, Trial Set, CM, and Anxiety

	df	Error	*F*-value	*p*-value
Main Effect				
Task				
Accuracy	1.00	79.00	222.85	< .001
RT	1.00	78.00	156.23	< .001
Set				
Accuracy	1.53	120.49	38.40	< .001
RT	1.47	114.44	58.28	< .001
Interaction				
Task x Set				
Accuracy	1.51	119.27	31.92	< .001
RT	1.69	132.08	4.06	0.025
Task x Set x CM				
Accuracy	1.51	119.27	4.80	0.017
Set x Anxiety				
Accuracy	1.53	120.50	6.20	0.006

Table 11

N-back, Trial Set, CM, and Emotion Dysregulation

	df	Error	*F*-value	*p*-value
Main Effect				
Task				
Accuracy	1.00	78.00	184.94	< .001
RT	1.00	78.00	150.37	< .001
Set				
Accuracy	1.49	117.98	29.97	< .001
RT	1.47	114.61	45.91	< .001
Interaction				
Task x Set				
Accuracy	1.49	118.03	31.60	< .001
RT	1.66	129.19	3.61	0.038
Task x Set x CM				
Accuracy	1.49	118.03	5.93	0.008

Exploratory Analyses: Set 2

Table 12

Emotion, Set, and CM Group

	df	Error	*F*-value	*p*-value
Main Effect				
Emotion				
Accuracy	3.48	319.84	10.53	< .001
RT	4	316.00	21.78	< .001
Set				
Accuracy	1.33	121.86	81.58	< .001
RT	1.57	123.87	58.72	< .001
Interaction				
Emotion x Set				
Accuracy	5.57	512.22	10.39	< .001
RT	6.77	534.82	7.41	< .001

Table 13

Emotion, Set, CM, and Anxiety

	df	Error	*F*-value	*p*-value
Main Effect Emotion				
Accuracy	3.44	309.93	10.25	< .001
RT	4	308.00	19.59	< .001
Set				
Accuracy	1.35	121.86	81.58	< .001
RT	4	308.00	19.59	< .001
Interaction Emotion x Set				
Accuracy	1.33	121.86	81.58	< .001
RT	1.56	120.44	48.07	< .001
Set x Anxiety				
Accuracy	1.35	121.35	5.50	0.013
Emotion x Set x Anxiety				
RT	6.83	525.93	3.02	0.004

Table 14

Emotion, Set, CM, and Emotion Dysregulation

	df	Error	*F*-value	*p*-value
Main Effect Emotion				
Accuracy	3.47	312.06	10.03	< .001
RT	4	308.00	17.32	< .001
Set				
Accuracy	1.34	120.93	63.32	< .001
RT	1.58	121.29	38.03	< .001
Interaction Emotion x Set				
Accuracy	5.53	497.43	7.87	< .001
RT	6.62	509.77	8.36	< .001
Emotion x Set x Emotion Dysregulation				
RT	6.62	509.77	2.55	0.016

Figure 10. Trial Set Accuracy for Low and High Anxiety

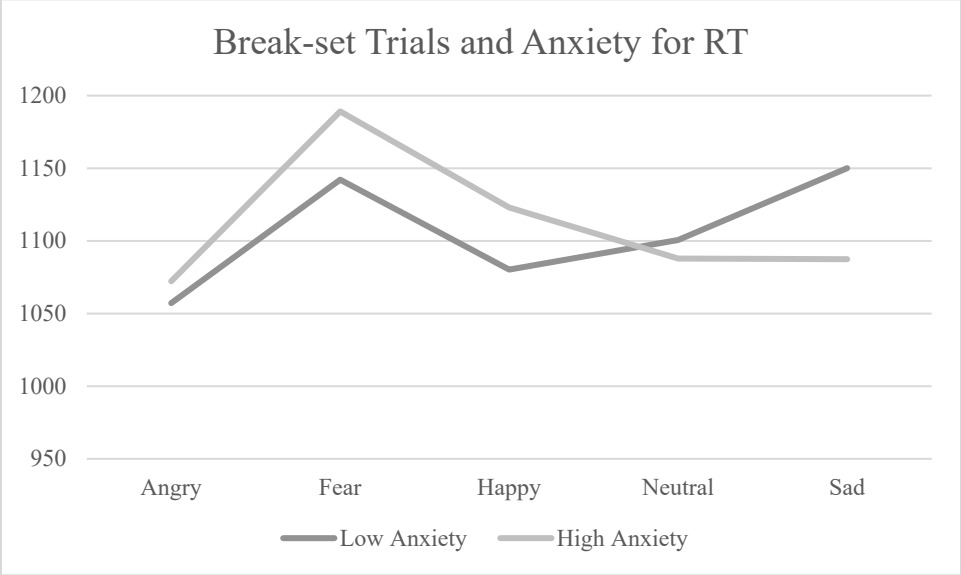


Figure 11. Break-set Trials and Anxiety for RT

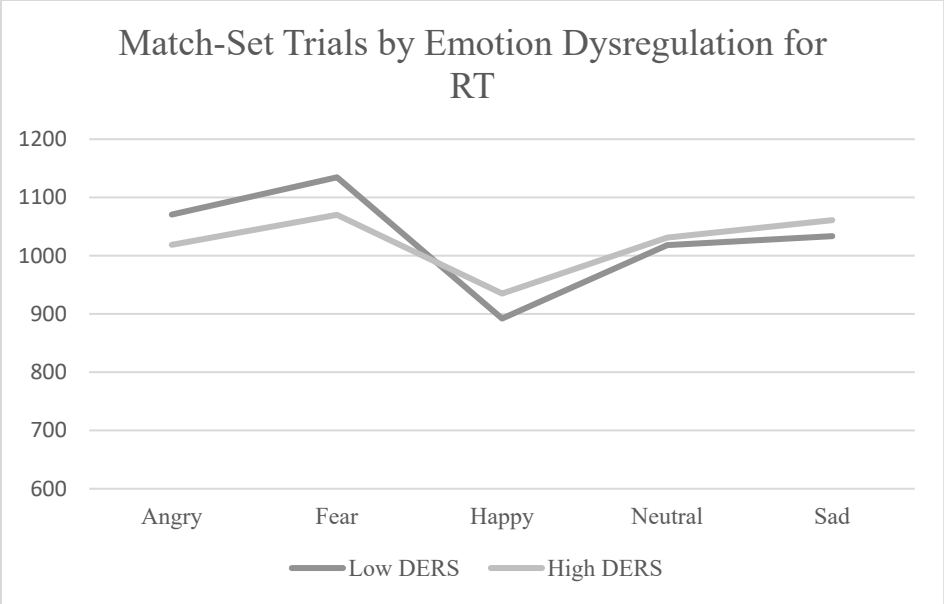


Figure 12. Match-set Trials by Emotion Dysregulation for RT